
A Chef's Guide to Gelling, Thickening, and Emulsifying Agents



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CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

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Version Date: 20140911

International Standard Book Number-13: 978-1-4822-9787-4 (eBook - PDF)

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HOW TO USE THIS GUIDE



The goal of this guide is to help chefs who want to learn the way to work with gelling agents, thickeners, emulsifiers, and foaming agents. The information needed is provided in a simple and practical format, describing the behavior of these technical products and applications for their use.

The contents of each chapter include (1) a description of the principal characteristics of each product, the various available types, and how to choose which to use depending on the aim of the result is explained; (2) the explanation on how to manipulate each texturizing product is related in order to achieve the best results possible; and (3) an example of a culinary use is done for each of the products.

Each chapter is organized according to the schematic shown in **Figure I.1**.

In this chapter we will describe the methodology used to obtain the results, the selection parameters, the kitchen procedures, the interpretation of outcomes, and some other concepts necessary for understanding the whole process.

The Appendix includes tables for each of the texturizing agents, summarizing the relative effectiveness of their gelling, thickening, emulsifying, or foaming properties. These tables can be used to compare the agents by category and by functionality.

There is also a global schematic at the beginning of Chapters 2, 3, and 4, listing the main characteristics of each category of texturizing agents (**Figure I.2**).

Please read each chapter in its entirety, as you may find answers to your questions in various sections.

ACKNOWLEDGMENTS



The form and content of *The Chef's Guide to Gelling, Thickening, Foaming, and Emulsifying Agents* has been influenced by both scientific research and the work of food professionals.

We would first like to thank all of the research fellows who have collaborated on this book. Since 2005, more than 40 people at the Alicia Foundation have contributed to the development of this book. Special thanks also go to the team at elBulli restaurant, which has been an important part of as well as inspiration for this work since its inception.

We also thank the chefs, pastry chefs, chocolatiers, and other food professionals who have offered their knowledge and recipes. This project would not have been possible without their unconditional support.

We also want to thank the BDN team for the expert review on the technical issues of the book. As a referent on applied food technology in Spain, their corrections and observations had been essential for the rigor of the contents.

And our most heartfelt thanks go to the Catalunya-La Pedrera Foundation for believing in culinary research from the very beginning, when the Alicia Foundation was just a germ of an idea of what evolved as the creation of something that had never been done before.

PROLOGUE



Global progress in the areas of cooking and nutrition depends increasingly on better education and training. Many educational and research institutions, companies, and professionals are involved in the essential work of generating and transmitting culinary knowledge. The Alicia Foundation has taken on the challenging task of distilling this knowledge into a compact, coherent, and dynamic form, with its innovative and exciting project *Bullipedia*. The Alicia Foundation is a pioneer in the area of bringing academic research and information to the general public, relying primarily on the kitchen and cooking as powerful forms of communication that will help to improve lives through better nutrition.

The Alicia Foundation employs a multidisciplinary team of professionals from diverse fields of expertise, such as nutrition, chemistry, food technology, and anthropology, who all work closely together. They reach out to people by way of their kitchens, helping them to eat well and better enjoy their food in the process. With this goal in mind, the foundation has studied the use of texturizing products in professional kitchens to bring some basic knowledge to home cooks, enabling them to put these often unfamiliar products to practical use in their own kitchens.

The use of these products has exploded around the world, and there is a great need for well-researched information on how to best use these products in both restaurant and home kitchens, which can be very different from their applications in the food industry.

Many of the scientific terms for the various texturizing agents have been identified in the book *Modern Gastronomy A to Z* (Scientific and Gastronomic Lexicon), which was published in 2006, and describes

their characteristics and properties. From there one can delve into the technological behavior of these products to establish some criteria for their use in the kitchen. In recent years restaurants have been experimenting with these texturizing agents, and in the process of doing so they have demonstrated the importance of the effect of texture in food. Understanding how to manipulate food textures not only is for chefs at high-end restaurants, but is also essential for all levels of the culinary establishment, including chain restaurants, catering businesses, and hospitals and school cafeterias.

Collaboration between scientists, technicians, and chefs has resulted in unique and creative culinary uses for some of these commonly available products. Building on this period of experimentation, this book attempts to collect years of culinary scientific research and the experiences of a diverse group of chefs who are eager to share their collective knowledge and recipes to public through this publication. The work presented in this book is a collection of practical knowledge about the principal gelling agents, thickeners, foaming agents, and emulsifiers that are used in commercial restaurants, with special emphasis on their applications.

The ultimate aim of this publication is to provide clear and practical information for professionals, culinary students, and amateur cooks. The Alicia Foundation is sharing the basic technical knowledge for being able to work with these products, but we must warn young chefs in particular that technology is merely a tool, not an end in and of itself. Studying and respecting the craft of cooking and following sound culinary practices are the only true guarantees for success in our profession.

Ferran Adrià



CHAPTER 1

Research on Texturizing Agents



TEXTURIZERS: AGENTS THAT MODIFY TEXTURE

Transformations in the texture of food are an intrinsic part of the cooking process. When determining the acceptance or the success of a dish or preparation, the tactile characteristics of food are as important in terms of human perception as taste, smell, and visual appearance. This concept is important when we define cooking as the universal and uniquely human strategy of consciously transforming our food resources into more edible forms. We differ from other living creatures in the cultural importance that we place upon cooking, a

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process through which knowledge is shared and adaptive reasoning is employed. In other words, cooking is both the art and the technique of creating food. Cooking is the method with which humans make good things to eat. The kitchen was one of the first examples of cultural adaptation that distinguishes humans from other animals. According to the evolutionary theory, certain biological adaptations take hold to improve the food access of species in their environment. Humans cook to make their environment more edible. Are we changing ourselves to adapt to our environment, or are we adapting our environment to suit our needs? This is a main question to answer.

The kitchen has evolved constantly to accommodate our interest in exploring the world of food textures in search of greater gastronomic delight. Many different kinds of experimentations have been involved: mechanical processes such as knife techniques and various types of high temperature treatments like oven, grill, and boiling water. Varying the combination and percentage of ingredients in a whole is another way to create better outcomes, especially for ingredients that are difficult to consume in their primary state. For example, cake flour has a texture that makes it unappealing for consumption as it comes, but when it is combined with sugar and eggs and subjected to the appropriate mechanical and thermal treatments it can be transformed into a unique preparation developing a texture that is highly pleasing to the majority of people.

TEXTURE

The word texture is used to describe the different physical properties (e.g., density, viscosity, surface tension, and hardness) of a product. Each of these properties can stimulate distinct senses during the act of eating.

Kitchen vocabulary, unlike scientific terminology, is irregular and often inconsistently applied. Even the most basic technical concepts can become a source of dispute between professionals from different schools of thought. You need to consider only the case of wine tasting, where there is still plenty of work to be done regarding the standardization of sensory perception terms.

Due to its complexity, the world of texturing agents requires its own vocabulary to be able to clearly define sensory experience. Chefs use many different words to describe texture: watery, airy, velvety, smooth, moist, meaty, creamy, crunchy, hard, elastic, thick, foamy, stringy, gaseous, or gelatinous, only to name a few. Other factors that influence the perception of texture must also be taken into account such as temperature, taste sensitivity, the environment in which the product is consumed, and the cultural preferences of the taster. This book attempts to synthesize these various factors or definitions into clear parameters being used in the perception of texture. In doing so, certain common threads can be identified, and giving answer to them will help simplifying and standardizing the information for professionals who will quickly understand the correct way to use each texturizer. At the same time, this simplification process can involve taking the risk of being overly reductionist or far outside the accepted scientific theory; the risk is taken with the determination of achieving the goal: providing quick, practical, and readily accessible information for professional chefs.

But what are texturizing agents, and what are they used for? They are used in the kitchen as products that modify the texture of food products, particularly liquids or purées.

The book establishes names or descriptive adjectives for texture and its variations, as shown in the following four categories:

1. *Gelling agents*: products that provide texture by forming gels and, based on their properties, belong to the hydrocolloid family
2. *Thickeners*: products that increase the viscosity of liquid state foods; also hydrocolloids
3. *Foaming agents*: products that cause the formation of foam in liquid state foods
4. *Emulsifiers*: products that allow the formation and the maintenance of an emulsion or homogeneous mixture of two immiscible liquids, such as oil and water

Later in the chapter, the characteristics of each group of texturing agents are defined in culinary terms.

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The following are standard definitions for various properties of texture (UNE, 1994):

Elasticity: Describes the speed and degree of recovery from deformation after the application of a certain force to a product. Related adjectives: plasti, elastic.

Hardness: Describes the force needed to deform a product or the force needed to penetrate the product with a certain object. Related adjectives: hard, soft, firm.

Viscosity: Describes the product's resistance to flow. Related adjectives: fluid, thick, viscous.

Adhesion: Describes the effort required to separate the surface of a product from the surface of a different product. Related adjectives: sticky, tacky.

Fragility: Describes the cohesion of a product, and the force necessary to break it into various pieces. Related adjectives: crumbly, crunchy, crisp, crunchy.

We will need to use a different type of terminology when describing the formation of foams and emulsions, which will be defined in the pertinent chapters.

Some texturizers have properties that allow them to fit into more than one category. For example, fish gelatin could be included in the chapters on gelling agents, emulsifying agents, and foaming agents. Most texturizers, however, are typically used in the kitchen for one primary purpose.

SELECTED PRODUCTS

The process of selecting the appropriate product for each function, like the research methodology behind this book, is the result of a close collaboration between the Alicia Foundation team and the chefs at elBullitaller, Ferran Adria's creative center in Barcelona.

Like it happens with the most common ingredients, a varied and extensive catalog of texturizing agents is available. This book includes only products that have been previously tested by the Alicia Foundation and those mostly used by major chefs in recent years. Certain popular

products may not be included in this book; this may be because the Alicia Foundation has not expressed sufficient experimental interest in them or finds them to have little gastronomic value.

When choosing an ingredient, a number of different questions are raised: What type of texturizing agent is it? What is it used for? Where does it come from? What is its most common commercial use? Which manufacturer makes it? The questions can be the same for each ingredient, and the correct answering of each of them will determine the success of the finished preparation.

For example, certain texturizing products may be manufactured by several companies, and although these products are produced for similar primary materials they often have different technical characteristics that must be taken into account. Each product is given a trade name (or code) from its manufacturer that is usually based on the methods used for its acquisition derived from the raw material.

To be able to differentiate between the various products offered on the market, it is important to understand each of them individually. When working with a known type of texturizing agent, it then becomes easier to predict how it can be manipulated in the kitchen.

Each company provides a series of parameters describing the physical and chemical characteristics of the main components of their products. If using a new product, it is very important to compare this data with the one given in this guide. If the product has highly differentiated physical and chemical properties one from the other or has fillers that have been added for enhanced functionality (e.g., maltodextrin or sugar derivatives), the methods and proportions for its use can vary substantially from the information provided in this book.

Nutritional data presented in the book are provided by the suppliers. Each company uses regulated and accredited analytical methods and must comply with the legal requirements of the determinate law, according to European Commission Directives 90/496 and 2008/100.

Information on dietary restrictions for allergies has also been provided by the suppliers. Each company uses its own analytical methods and must comply with legal regulations (Food Allergen Labeling and Consumer Protection Act (FALCPA) and Directive 2000/13/EC,

amended by EU 2003/89/EC, 2006/142/EC and 2007/68/EC at time of publishing). The Food Allergen Labeling and Consumer Protection Act (FALCPA), effective January 1, 2006, requires clear labeling of food products containing the following eight major food allergens: peanuts, soy, milk, eggs, fish, shellfish, tree nuts, and wheat. Amendment 2003/89/EC to the EU Labeling Directive 2000/13/EC requires the labeling of food products containing the following allergens: cereals containing gluten, crustaceans, eggs, fish, peanuts, soy, milk and dairy products (including lactose), nuts, celery, mustard, sesame seeds, and sulfur dioxide and sulfites in concentrations higher than 10 mg/kg or 10 mg/liter.

The following document describes the technological and nutritional characteristics of each product, including information about allergens and dietary restrictions.

SELECTION METHODS

Because of the large variety of texturizing agents available, and as explained previously in this chapter this research focused on certain brands for each product. After several comparison tests, selection is based on the first place on the technological properties of the products as well as on the previous culinary analysis.

The basic criteria for the initial selection of manufactured products are as follows:

1. **The product must be safe for food use.** Some technological products are produced for pharmaceutical or chemical applications and therefore are not subject to the strict guidelines outlined in the food safety standards. The selected product and its compounds meet the specifications of the FAO/WHO, EU, FDA, and the Food Chemicals Codex. It is strongly recommended for consumers to check local and national regulations for the food use of any technological product.
2. **The product must have a minimum aftertaste in the finished preparation.** The first test to be done in the selection of a texturizing agent is to taste it in its natural form (e.g., powder, flakes). It

is then dissolved in a neutral medium (water or oil, depending on the original product) to see if its taste can be detected in the solution in a wide range of texturizer ratios following the manufacturer's information. The selected product can provide a minimum residual flavor to the final preparation but should not overshadow the rest of the flavors or the gustatory nuances of the original food products. This observation is very important because many available texturizers are produced differently, and the degree of residual taste can vary widely in noncommercial use (the kitchen versus the food industry).

- 3. The product must always produce the same effect when used according to instructions.** Products come with specific manufacturer's instructions for their commercial use, but when they are used in a particular kitchen environment the manipulation parameters may change.

TABLE OF SELECTED TEXTURIZING AGENTS

The following tables list the principle characteristics and qualities of each of the four types of texturizing agent as well as the differences detected between them and the corresponding commercial products.

In addition to the texturizing agents, calcium salts have also been included as a separate chapter. The motive is their gelling effect when brought in contact with the texturizer sodium alginate in the gel spherification technique. The calcium salts that are explained are calcium chloride and calcium gluconolactate.

RESEARCH METHODOLOGY

Each product described in this book has an optimum concentration range, with the corresponding specific methodologies and possible preparations.

Most of the parameters are provided by the manufacturers, but there is often a gap between the industrial application of a product and its practical use in the kitchen. These environments can be very different regarding factors such as equipment, amount of product used, and

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Gelling Agents	Main characteristics	Product varieties	Characteristics of product selected for testing
Gelatin	Creates soft and elastic gels that melt at low temperatures (melts in mouth). Food preparations containing gelatin can be frozen and defrosted.	Gelatin sheets and gelatin powder. The two types have different gelling strengths, which are measured in degrees of "bloom".	Gelatin sheets are easily dispersed into solution and do not produce residual taste in the final product. Gelatin powder may have some aftertaste.
Agar-Agar	Creates a rigid and brittle gel that can withstand high temperatures. Preferred gelling agent for hot gels.	Agar-agar powder, produced by refining translucent algae filaments.	Agar-agar leaves a very light residual taste. Resulting gel is less opaque than other gelling agents.
Sodium Alginate	Used in spherification technique. Produces thermoirreversible gels that will not melt when heated.	Sodium alginate powder. There is a wide range of products available, with varying amounts of viscosity, gelling capability, and grade of refinement.	The product that we tested produced medium viscosity, and was easy to work with. Can be used for spherification, but leaves a slight residual taste of algae.
Kappa Carrageenan	Produces fast setting gels that can be prepared instantly. Gel texture is brittle and nonelastic at normal concentrations.	Kappa carrageenan powder. This product is available in many different gelling strengths.	Tested product is one of the most refined available, which contains potassium chloride to improve the gelling process. Final product has almost no residual taste of algae and is also clear – a rare combination.
Iota Carrageenan	Resulting gel is soft and elastic, and can be served warm (depending on the concentration used). Resulting gel is thixotropic-it can be broken and will reform. The texture is similar to gels made with gelatin.	Iota carrageenan powder. This product is available in a wide range gelling strengths.	Selected product is very easy to use as it contains sodium chloride, which improves gel formation.
HM Pectin	Used throughout the food industry in the production of jams, jellies, and marmalades. One of the most widely used gelling agents for pastry and desserts.	Pectin powder. Available in many different gelling strengths. Reacts differently in the presence of sugar and acids. Minerals can be added to improve gelling capability.	Tested product is one of the most widely used products in the food industry that is used to make standard gels.
LM Pectin	Widely used in the food industry to produce jams, jellies, and marmalades with low sugar content.	Pectin powder. This product is available in a range of gelling strengths, reacts differently with calcium, and can contain minerals to improve gel formation. Modified LM pectins are called LMA (amidated low methoxyl) pectins.	Tested product is the most pure and refined of the conventional LM pectins, which is ideal for preparing low sugar jams.

FIGURE 1.1 GELLING AGENTS.

intended use of the product. One major difference is shelf life—the food industry requires its products to have a long shelf life, while the restaurant kitchen is characterized by immediacy and high turnover of raw materials and preparations. This book attempts to establish the optimal methodology for the culinary use of these texturizing agents, which sometimes differ from academic information or from the manufacturer's specifications.

Thickening Agents	Main characteristics	Product varieties	Characteristics of product selected for testing
Cornstarch	Cornstarch is the most widely used thickener in both the food industry and kitchen. It produces high viscosity but creates opacity and leaves some residual mouthfeel.	Natural cornstarch powders only vary slightly in viscosity, but modified cornstarches can vary quite a bit.	Tested product is a natural starch and is commonly used in the kitchen, which makes standardizing the thickening process very straightforward.
Kudzu Starch	Kudzu starch is very versatile in terms of possible preparations. It can be used in low concentrations, and provides a more pleasant mouthfeel than other starches.	Kudzu starch is available in different grain sizes. Some kudzu starch products include other starches in the formulation.	Tested product is easily dispersed and produces a light texture even at a high concentration.
Xanthan Gum	One of the most versatile thickeners. Can be used at any temperature.	Xanthan gum powder is processed into varying grades of refinement, which produce different viscosities and opacities in the solution.	Tested product is particularly transparent, and leaves no residual taste if used in small quantities.
Locust Bean Gum	Locust bean gum is a thickener that is in very low quantities. It produces a greasy texture and produces a very soft gel in combination with xanthan gum.	Locust bean gum is available in a range of strengths, allowing for control of viscosity and dispersion.	The product tested is one of the most refined thickeners, and does not leave any residual taste.
Guar Gum	Guar gum has a very robust thickening capacity, and is therefore widely used in the food industry.	Guar gum is available in a range of strengths, allowing for control of viscosity and dispersion.	The product tested is one of the most refined thickeners, and does not leave any residual taste.
Tara Gum	Tara gum has a very high thickening capacity, and produces a very soft gel in combination with xanthan gum.	Tara gum is available in a range of strengths, allowing for control of viscosity and dispersion.	The product tested is one of the most refined thickeners, and does not leave any residual taste.

FIGURE 1.2 THICKENING AGENTS.

Foaming Agents	Main characteristics	Product varieties	Characteristics of product selected for testing
Egg White Powder	Has high foaming capacity and gels with the application of heat, just like fresh egg whites. Good for creating a strong flavoured meringues and other foams.	Egg white powder is available in many different particle sizes and may be mixed with stabilizers.	The tested product is solely composed of egg white powder, and leaves a certain residual taste to the food preparation.
Gelatin	Wide range of products, capable of producing stable foams with very light textures. Very useful for the siphon technique.	Sheet gelatin and gelatin powder. In both cases, different gelling strengths available, measured in degrees bloom.	Sheet (leaf) gelatin disperses easily and does not leave a residual taste in the final product. Gelatin powder may leave some residual taste.
Methylcellulose	Methylcellulose produces foams which gel with the application of heat.	There are many different types of methylcellulose, with different grades of viscosity, different gelling capacities, and varying degrees of temperature resistance.	The selected product is the one used for gel formation, and is very versatile.
Lecithin	Lecithin has excellent foaming capacity as well as emulsifying properties. But produces a very light texture with limited shelf life.	Available in both liquid and powder forms. Powder is available in many different particle sizes.	Selected product is the powder form, which incorporates easily, leaving little residual taste in the final product.
Sucrose Ester	Sucrose ester has great foaming capacity and can aerate alcoholic products. But produces a very light texture with limited shelf life.	Sucrose ester is available in different particle sizes, but all have the same properties.	The selected product is the powder form, which incorporates easily, leaving almost no residual taste in the final product.

FIGURE 1.3 FOAMING AGENTS.

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Emulsifying Agents	Main characteristics	Product varieties	Characteristics of product selected for testing
Mono-Diglycerides	Stabilize water-in-oil emulsions and permit stable mixing of two or more normally immiscible liquids.	Mono-diglycerides are available in flaked and powder forms, which have the same functionality.	Tested product is the one most commonly used in the food industry.

FIGURE 1.4 EMULSIFIERS.

Others	Main characteristics	Product varieties	Characteristics of product selected for testing
Calcium Lactate Gluconate	Calcium lactate gluconate is ideal for enriching calcium without leaving a salty taste in the final product.	Results do not change depending on the form used as long as the concentration remains the same.	The selected product provides the right amount of calcium for the sodium alginate to gel.
Calcium Chloride	Used to make calcium bath for the spherification technique only. Fast to dissolve and produces a high calcium concentration in the water.	Available dried in various particle sizes, or dissolved in liquid.	Tested product is in powder or flaked form and leaves a very strong residual taste if it's not used in the right proportions.

FIGURE 1.5 CALCIUM SALTS.

STUDY PARAMETERS FOR THE APPLICATION OF TEXTURIZING AGENTS

In the kitchen, certain parameters such as work teams and food products cannot be controlled as they are variable by nature (and are one of the great assets of the kitchen) and are impossible to be standardized. It is possible, however, to establish certain parameters for the control of the following variables.

TASTING PANEL

All experiments were tested, described, and characterized by a tasting panel of chefs and food technologists who are specialized in new cooking techniques at the Alicia Foundation. Before each test, tasting notes were prepared with the principle food descriptor terminology so that the panel could optimally describe the attributes of each preparation.

MEASUREMENTS FOR PERCENTAGE AND WEIGHT

Due to variations in weight and volume, the culinary industry uses a standard percentage system for recipes. To simplify and standardize the process the culinary (or relative) percentages system has been used in the trials, though this system doesn't differ substantially compared with the strict scientific percentage system as most of the texture-modifying agents are added in very small proportions. To exemplify this percentage working method the following example is explained. The addition of 0.3% of xanthan gum to a product means practically that the real addition is of 0.3 grams of xanthan gum to 100 grams of product obtaining a whole of 100.3 grams. The scientific percentage would mean the addition of 0.3 grams of xanthan gum to 99.7 grams of product obtaining 100 grams of the whole. Throughout the book, the data expressed as a percentage ratio always refer to these kinds of relative percentages. Even starches, which are generally used in much higher proportions than other texturizers, are listed in relative percentages make to comparison between the texturizing agents easier.

SERVICE TEMPERATURE

The service temperature is considered hot when it reaches temperatures between 60°C/140°F and 80°C/176°F. Regardless the type of final preparation, the temperature must be greater than 60°C/140°F to be considered hot by the chef as well as by the client.

SERVICE TIME

The service time is defined as the length of time between the completion of the preparation of the dish and time it is delivered to the consumer in the serving area. This time becomes significant when assessing the suitability of certain preparations for different types of facility or service. In an effort to standardize the process, a restrictive service time of 20 minutes will be the supposing working time used in the trials.

HEAT RESISTANCE CONDITIONS

The heat resistance of a texturizing product is an important factor to be contemplated. The ability of maintaining certain preparations such as gelatins or foams, in high temperature conditions, is one the most important advances achieved in the development of texturizing agents. The behavior of various texturizing agents has been studied under different working conditions (e.g., water, water enriched with other ingredients, combination with of solutions with other basic foods) when subjected to the required service temperatures for customers:

- In a convection oven: a system of controlled temperature, with a homogeneous heat under normal conditions
- In a broiler (salamander): a fast and frequently used heat source for heating finished dishes for the service or for instant cooking
- In hot or boiling water: the heat transfer from boiling water to food is very homogenous; one of the mainly used cooking and heating techniques in the world (along with deep frying)
- In a pan: heated directly by the pan or fried in oil
- In a microwave: a quick way to heat food but difficult to control when rapidly heating food that reach high temperatures; microwave action in heating products is irregular

FINAL PRODUCT CONSERVATION

The preservation of texturized products is critical since the cooking preparations must often take place days in advance of the moment they have to be served to have a sufficient supply. Although some preparations can be frozen ($-18^{\circ}\text{C}/-0.39^{\circ}\text{F}$) to prolong their preservation time, most can only be kept in the refrigerator ($4^{\circ}\text{C}/39.2^{\circ}\text{F}$) for a short period so they can maintain their properties. Having explained these conditions it's important to note that the goal of a restaurant is to have quick product turnover and the freshest ingredients possible even though this is not always easy to control. The shelf life of a product is another important consideration as well as the conservation of its optimal organoleptic properties. Proper food handling practices were followed when working and preserving the products.

THE FOUR STAGES OF RESEARCH

This research is based on four methodologies that were applied to the products to understand their behavior in the kitchen. There was an initial phase, Phase 0, in which the Alicia Foundation crew documented the origin, properties, and common uses of the products in depth, using the technical specifications supplied by the manufacturer as well as the many available publications about texturizing agents. This phase, much more scientific and with more appliance to industrial use, is considered separately from the work practiced in the kitchen, as the products can behave differently in the unique conditions of a kitchen separately from how they behave in industrial use. In some cases what happens at the kitchen stove contradicts the scientific theory.

Though thorough background research has been studied, once the manipulation of the products in the kitchen starts the observation of the behavior of the same must be done without preconceptions. Following are the four methodologies that are observed for every texturizer.

BEHAVIOR IN WATER

In the first part of the study, the observation of the behavior of the texturizing agents is done in a simple water solution, since water is the more neutral liquid known. The result becomes a reference point for subsequent experiments. Moreover, almost all food products contain water in varying amounts (except for oils, salt, sugar, and other few ingredients). If the product is a liquid or a puree, the water content is even greater because of blending, juicing, or other processing methods used for its conception. To determine the optimal initial concentration range for each product, the recommended amounts written by the manufacturer were used to be later refined, achieving the concentrations that better adapted to the kitchen environment. Once the ideal concentration for culinary use is determined, the result is compared to the dosages permitted by current recommendations at the time of publication. Before using any texturizing agents, it is very important to review and consider all of the regulations implying their use.

BEHAVIOR IN ENRICHED WATER

In this second part of the study, the objective is to understand how the texturizing agent behaves in water enriched with certain ingredients. This series of tests reduces the number of experiments since it is possible to approximate how a texturizing agent will behave with food with similar characteristics. For example, if agar-agar demonstrates problems in an assay done with water and citric acid, it's easy to predict that the same problems will take place working with agar-agar with citrus juices or other highly acidic media. The different texturizers are tested in water solutions with different concentrations of the following products: sugar (sucrose), salt (sodium chloride), citric acid, and calcium chloride. These are chosen because they are known as the main food components that can interfere with the effectiveness of texturizing agents.

BEHAVIOR WITH FOOD PRODUCTS

In the third stage, the texturing agents are tested with various common foods used in the kitchen. Some particular characteristics of each texturizer can be better understood by seeing their reaction within a specific environment. To obtain the more objective results possible, the tests are repeated several times (a minimum of three attempts if no complication occurs) so different results are obtained. The foods that are selected for this stage of the research have specific characteristics beyond those of the components that were tested in water. These characteristics may influence the technological process or may outcome when working with texturizing agents.

The composition of food is important because it can affect the functionality of a texturizing agent, but it is not possible to analyze the reaction of every texturizer with every single kind of food. Some indicative markers (food products) had been identified for the first phase of testing (the industrial application), which are then tested further in the culinary phase. With which criteria are the products selected can be a question to answer. Several criteria led to the selection of these products at the beginning of the research in 2005, which represent the

most variable selection of food products able. Because of the high level of complexity in the world of kitchen and cooking, these markers could be replaced without much difficulty, with very similar outcomes (see Annex 5).

It is essential to have the values about the water content of a food to establish whether it is sufficient for a good dispersion and subsequent hydration of the texturizing product, as for example hydrocolloids require a high water content. Alcohol is sometimes used in the kitchen, but not so often in the food industry. Since few references in the literature are provided by the food industry, research on how texturizing agents behave with alcohol is important and is put to practice in the work.

CULINARY PREPARATIONS

The information obtained through this research allows us to establish a list of possible preparations that can be created with each texturizing agent. Although texturizers may have a combination of different properties and abilities, such as gelling, thickening, foaming, or emulsification, the principle property and primary culinary uses of each texturizing agent was the motive to elect it as a specific type of texturizer.

PREPARATIONS AND TECHNIQUES OF TEXTURIZING AGENTS

Figures 1.6 and 1.7 show the primary preparations that can be obtained with each texturizing agent studied. Like the products used in food testing, these preparations and their designations occur under the specific conditions of the Alicia Foundation, which have remained constant. Their usefulness is limited, however, and in no way intended to be universal because unfortunately there is no absolute consensus on culinary terminology. Our hope is that professional chefs will be able to understand the concepts specified therein.

The main purpose of this book is to provide guidelines for cooks who want to create unique dishes with texturizing agents.

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Preparations	Definition	Descriptions of Texture
Sauce	It is a flavored liquid with certain viscosity designed to accompany food.	Thick liquid texture
Emulsified Sauce	Emulsion of fat and liquid usually made with vegetable oil, egg yolks, and other ingredients.	Thick and creamy texture.
Nectar	Similar texture to the undiluted fruit juice, or a mixture of fruit juices.	Smooth liquid texture.
Liquid Cream	Texture is slightly thicker than a sauce and usually with some kind of fat content. It is the typical texture of creamed vegetables.	Smooth and lightly thick liquid texture.
Thick Cream	Thicker than light cream, and still fluid but closer to a solid texture. Texture of crème brûlée.	Smooth and thick liquid texture.
Puree	Food that is finely mashed to a smooth, thick consistency.	Smooth, thick consistency.
Texture Flan	Texture of traditional baked custard. It has a gelled structure that is very soft and fragile.	Smooth texture.
Gelee	Gelled liquid. The range of texture can vary but is always soft.	Smooth and sticky texture.
Nappage	A liquid with enough viscosity to cover certain foods, flavoring them and giving them texture, color and brightness.	Thick and fluid texture.
Air	Foam produced with immersion blender, by incorporating air and forming large bubbles that produces an extremely airy texture.	Large bubbles similar to soap foam. Collapse instantly in mouth.
Soft Meringue	A texture of stiffly beaten eggs whites with granulated sugar.	Foam with small bubbles.
Hard Meringue	Texture of a soft meringue that is baked at a very low temperature (about 93°C/ 200°F) for as long as 2 hours, or until completely dry, or just until crisp on the outside and chewy inside.	Crunchy texture.
Jam & Marmalade Texture	A thick mixture of fruit, sugar that is cooked until the pieces of fruit are very soft and almost formless.	Chunky and sticky texture.
Aspic	Preparation with pieces of food suspended in a gel.	Brittle or smooth jelly with chunks.
Thin Gel Layers to Wrap	Very thin pieces of gel that are flexible and can be manipulated.	Very slim texture
Jelly Bean	Small candy, with has a chewy, gelatinous texture inside.	Chewy, gelatinous texture with hard or soft candy texture.
Mousse	It is a rich, airy dish that can be either sweet or savory.	Rich, airy texture.
Espuma	Foam produced by a whipping siphon, primed with a cartridge of nitrous oxide.	Foam with small bubbles. Long-lasting in mouth.
Ice Cream & Sherbet	Frozen mixture of sweetened fruit juice (or other liquid) and milk or water.	Rich smooth frozen texture.
Suspension Effect	A dispersion of fine solid or liquid pieces into a fluid, that is stable over time.	Liquid texture with solid chunks
Spherification	Gelled product in with a liquid core and a resistant gel skin.	Gel texture in the layer and liquid inside.

FIGURE 1.6 FINAL PRODUCTS OBTAINED WITH THE USE OF TEXTURIZING AGENTS.

		TEXTURES*													PREPARATIONS**									
		Sauce	Emulsified Sauce	Nectar	Liquid Cream	Thick Cream	Puree	Texture Flan	Gelée	Nappage	Air	Soft Meringue	Hard Meringue	Texture Iam & Marmalade	Aspic	Thin Layers To Wrap	Jelly Bean	Mousse	Espuma	Ice Cream & Sherbet	Suspension Effect	Sterification Technique		
Gelling Agents	Gelatin	✓	✓	✓	✓	✓	✓✓	✓✓	✓	✓	✓	✓✓	✓	✓✓	✓	✓✓	✓	✓✓	✓✓	✓	✓	✓		
	Agar-Agar	✓	×	×	×	✓	✓	✓✓	✓✓	✓	×	×	✓	✓✓	✓✓	✓✓	✓	×	×	×	×	×		
	Sodium Alginate	×	×	×	×	×	×	×	✓	×	×	×	×	✓	✓	×	✓	×	×	×	×	✓✓		
	Kappa Carrageenan	×	×	×	×	×	✓	✓	✓✓	✓✓	×	×	×	✓	✓	✓	✓	×	×	×	×	×		
	Iota Carrageenan	✓	✓	✓	✓	✓	✓	✓✓	✓✓	✓	×	×	×	✓	✓	✓	✓✓	✓	✓	✓	✓	✓		
	Elastic (High Acyl) Gellan Gum	✓	×	✓	✓	✓	✓	✓	✓✓	✓	×	×	×	✓	✓✓	✓	✓	✓	×	✓	✓	×		
	Rigid (Low Acyl) Gellan Gum	×	×	×	×	×	✓	✓	✓✓	✓✓	×	×	×	✓	✓✓	✓✓	✓✓	×	×	×	×	✓		
	Methylcellulose	×	×	×	×	×	×	✓	✓✓	✓	×	✓	✓	×	✓	×	✓	✓	✓	×	×	×		
	Hm Pectin	×	×	×	×	×	×	×	✓	×	×	×	×	✓✓	✓	×	×	×	×	×	×	×		
	Lm Pectin	×	×	✓	✓	✓	×	✓	✓	✓	×	×	×	✓✓	✓	×	×	×	×	×	✓	✓		
Thickening Agents	Cornstarch	✓✓	✓	✓	✓✓	✓✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	✓	×	×		
	Kudzu Starch	✓✓	✓	✓	✓✓	✓✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	✓	×	×		
	Xanthan Gum	✓✓	✓	✓✓	✓✓	×	×	×	✓	×	×	×	✓	×	×	×	×	×	×	✓	✓✓	×		
	Locust Bean Gum	✓✓	✓	✓✓	✓✓	✓✓	✓	×	×	✓	×	×	×	✓	×	×	×	×	×	✓	×	×		
	Guar Gum	✓✓	✓	✓✓	✓✓	✓✓	✓	×	×	✓	×	×	×	✓	×	×	×	×	×	✓	×	×		
Emulsifiers and Foaming Agents	Tara Gum	✓✓	×	✓✓	✓✓	✓✓	×	×	×	✓	×	×	×	✓	×	×	×	×	×	✓	×	×		
	Egg White Powder	×	×	×	×	×	×	×	×	✓	✓✓	✓✓	×	×	×	×	✓✓	✓✓	✓	✓	×	×		
	Lecithin	×	✓	×	×	×	×	×	×	✓✓	×	×	×	×	×	×	×	×	×	✓	×	×		
	Sucroester	×	✓	×	×	×	×	×	×	×	✓✓	×	×	×	×	×	×	×	✓	✓	×	×		
	Mono-Diglycerides	×	✓✓	×	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	✓	✓	×	×		
		✓✓	It is very appropriate.																					
		✓	It can be used.																					
		×	Not applicable																					

✓✓	It is very appropriate.
✓	It can be used.
×	Not applicable

FIGURE 1.7 POSSIBLE CULINARY TECHNIQUES WITH TEXTURIZING AGENTS.

Figure 1.7 summarizes some of the most important research done. All possible uses for each texturizing agent are presented, from very simple techniques to the one almost impossibly difficult to perform.

Keep in mind that only the techniques in which the texturizing agents play a major role are the ones considered in this book. Texturizers have other purposes and can also be used as stabilizers, anticaking agents, between other uses, but these properties have not been included in the work:

- The textures presented in Table 1.2 are a random sample of different possibilities that can be achieved with a product to provide an idea of the different possibilities to be done. These are not necessarily the only textures that can be produced or the appropriate names for them. These are only examples, and they can vary depending on many different factors.
- These examples of how texturizing agents can be used provide a guideline for further experimentation. Of course, the real range of possibilities is much too great to fit into a summary table.



CHAPTER 2

Gelling Agents



GENERAL PROPERTIES OF GELLING AGENTS

WHAT IS A GEL?

A gel is a colloidal dispersion of a solid within a liquid. The unique texture of gels is obtained due to their characteristic three-dimensional network structure. In addition to the use of gelling agents, there are many examples of classic gels in traditional cooking, such as puddings and jellied consommés.

Gels generally have high water contents and are prepared from foods in liquid or semiliquid states. Although the word gelatin or gelatine (both accepted) technically describes gels prepared with animal

collagen, many culinary professionals still use the word *gelatin* to describe all kinds of gels, regardless of the gelling agent used to achieve them.

HOW DOES A GELLING AGENT WORK?

Gelling agents have the ability to trap water molecules inside the network formed because of the hydrocolloid properties that they possess. The trapped water in the network formed gives texture to the liquid, as the gel is formed.

There are two steps for the gelling process:

1. *Dispersion*: The gelling agent must be mixed into the liquid phase in a homogeneous manner.
2. *Hydration*: After the gelling agent disperses into the liquid, the hydrocolloid molecules must form a network with water. Most commonly this is achieved by the action of heat, although in some cases agitation is sufficient.

Once these steps are achieved, the network of hydrocolloid molecules in solution bond together as the solution cools because the texturizing agent finds the necessary ions in the solution, such as calcium, to make the network and also due to interactions within molecules themselves like the proteins of gelatin.

PRINCIPLE CHARACTERISTICS OF GELLING AGENTS

There are many types of gelling agents, each with different dispersion and hydration characteristics, which produce gels of varying strengths. Depending on which gelling agent is used, the final products have very different textures and degrees of heat resistance.

Figure 2.1 shows the most common gelling agents that can be used to texturize food and their main characteristics.

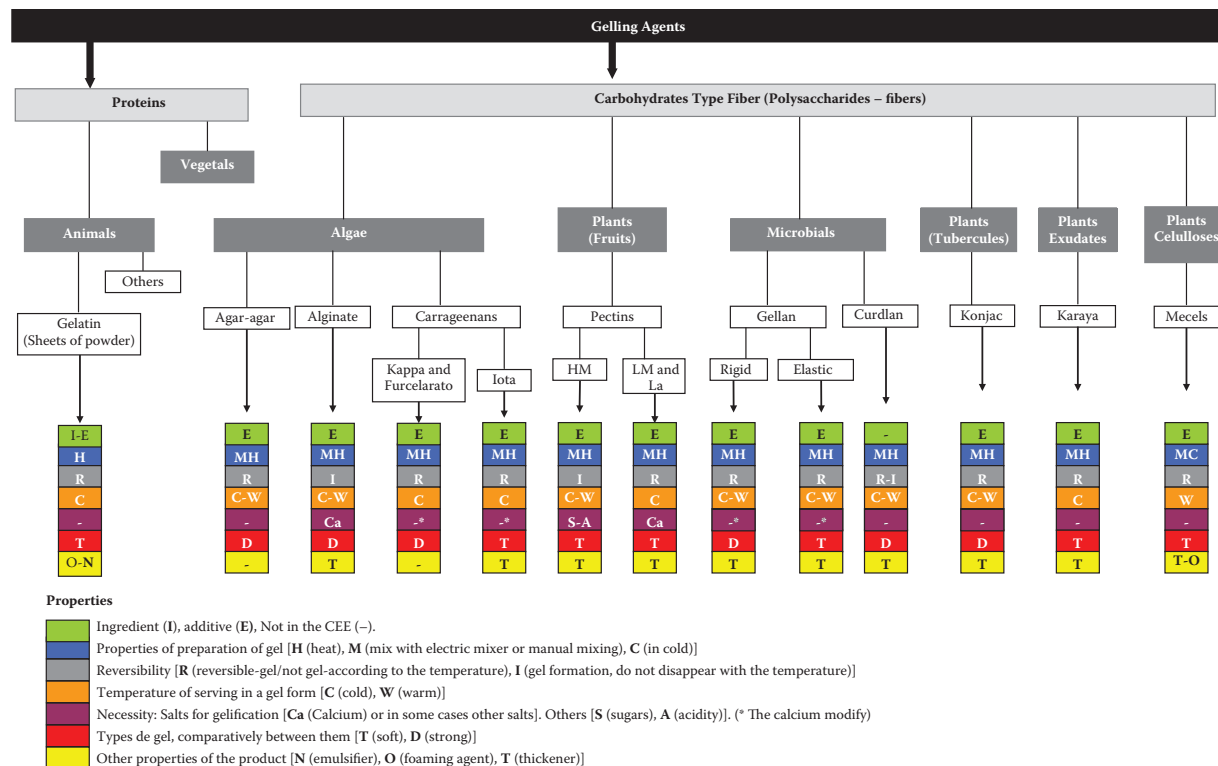


FIGURE 2.1 COMMON GELLING AGENTS USED TO TEXTURIZE FOOD.

		Textures*												Elaborations**								General Concepts			
		Sauce	Emulsified Sauce	Nectar	Liquid Cream	Thick Cream	Puree	Texture Flan	Gelee	Nappage	Air	Soft Meringue	Hard Meringue	Texture Jam & Marmalade	Aspic	Thin Layers To Wrap	Jelly Bean	Mousse	Espuma	Ice Cream & Sherbet	Suspension Effect	Sferification Technique	Cold Elaboration	Warm Elaboration	
Gelling Agents	Gelatin	✓	✓	✓	✓	✓	✓	✓✓	✓✓	✓	×	✓	✓✓	✓	✓✓	✓	✓✓	✓✓	✓✓	✓	×	×	✓	×	
	Agar-Agar	✓	×	×	×	×	✓	✓✓	✓✓	✓	×	×	×	✓	✓✓	✓✓	✓	×	×	×	×	×	✓	✓	
	Sodium Alginate	×	×	×	×	×	×	×	✓	×	×	×	×	✓	×	×	✓	×	×	×	×	✓✓	✓	✓✓	
	Kappa Carra-geenan	×	×	×	×	×	✓	✓	✓✓	✓✓	×	×	×	✓	✓	✓	✓	×	×	×	×	×	✓	✓	
	Iota Carrageenan	✓	✓	✓	✓	✓	✓	✓✓	✓✓	✓	×	×	×	✓	✓	✓	✓✓	✓	✓	✓	✓	✓	✓	✓	
	Elastic Gellan Gum	✓	×	✓	✓	✓	✓	✓	✓✓	✓	×	×	×	✓	✓✓	✓	✓	✓	×	✓	✓	×	✓	✓	
	Rigid Gellan Gum	×	×	×	×	×	✓	✓	✓✓	✓✓	×	×	×	✓	✓✓	✓✓	✓✓	×	×	×	×	✓	✓	✓✓	
	Methylcellulose	×	×	×	×	×	×	✓	✓✓	✓	×	✓	✓	×	✓	×	×	✓	✓	×	×	×	×	✓	
	Hm Pectin	×	×	×	×	×	×	×	✓	✓	×	×	×	✓✓	✓	×	✓✓	×	×	×	×	×	×	✓✓	
	Lm Pectin	×	×	✓	✓	✓	×	✓	✓	×	×	×	×	✓✓	✓	×	✓	×	×	×	×	✓	✓	✓	
		✓✓	It is very appropriated.																						
		✓	It can be used.																						
		×	Not applicable																						

FIGURE 2.2 ELABORATIONS THAT CAN BE MADE WITH THE VARIOUS TYPES OF GELLING AGENTS.

PROPERTIES OF GELLING AGENTS

Gelling agents can be classified into the following categories, based on the comparison of results produced in a gel with equal concentrations of the different gelling agents:

- *Hard gelling agents*: those that produce firm, rigid, and brittle gels
- *Soft gelling agents*: those that produce gels with a smoother texture, are less resistant to chewing, and are in some cases more elastic

HARDNESS

One of the fundamental parameters for the culinary use of gelling agents is the texture that the gel produces in the final product, that is, the gel's resistance to chewing. The degree of hardness of culinary gels is described using the terms *soft*; *medium hard or firm*; and *hard*.

Gel hardness depends on both the type of gelling agent employed and the concentration used to create the gel. If a harder gel is preferred, the concentration of the gelling agent should be increased. Likewise, the concentration can be decreased to produce a softer gel.

The ideal hardness of the gel depends on the desired final product. For example, if you are working with mild flavors (e.g., apple juice or broth) and intend to serve a large amount of gel with a mild flavor, the gel should be very soft with a low concentration of gelling agent used. On the other hand, if the gel is intended to bring a complementary and intense flavor note (e.g., soy sauce, vinegar), the quantity of the gel consumed will be smaller but should have a higher concentration of gelling agent so that the gel will be harder and linger longer in the mouth, enabling the flavor to persist.

ELASTICITY

Elasticity is defined as a mechanical property of the gel. Gels have different degrees of elasticity: some are not elastic and break irreversibly

when subjected to a force, while others are elastic and can withstand distortion. In culinary use, nonelastic gels are defined as brittle.

ABOUT GELLING AGENTS

This chapter describes some of the gelling agents most commonly used in gastronomy and addresses their differences to provide a better understanding of them and allowing and facilitating their use.

We recommend an entire lecture of the chapter, as you will find answers to some of the common questions about each product as you read along. For each product mentioned the following categories of information are provided.

HOW THE PRODUCT IS USED AS A GELLING AGENT

In this section, we give a general overview of the gelling agent and its main features, including the origin, possible allergens, final texture, and mouthfeel.

INSTRUCTIONS FOR USE

This section provides the following information:

- Preparation of the gelling agent: This section provides the specifications for the use of each gelling agent. We describe the steps and the necessary proportions as well as proper handling and best practices for achieving optimal results:
 - Guidance on the minimum and maximum amounts of gelling agent to use depending on the various types of products and desired results
 - The minimum amount of liquid necessary to obtain good results and to avoid preparation problems (e.g., excess evaporation, agitation) that might alter the final result
 - The temperatures required for each step of the preparation and the method needed to apply very precise temperatures if needed

- Whether the gelling agent needs strong, medium, or no agitation for good dispersion. This will determine which tools are needed (handheld electric mixer versus whisk or spoon) as well as the possible problems occurred within the incorporation of air into the gel
- Some gelling agents are capable of becoming hydrated added in only one part of the total liquid to gel, so then the mixture can be added to the other part of the liquid without affecting the final result. This is useful when the product that is to be gelled can lose flavor, aroma, or other organoleptic characteristics during the heating process needed for the total dispersion or hydration of the gelling agent.
- Information on the characteristics of the resulting gel: foods with which it can be prepared and how to troubleshoot problems.
 - Time required for obtaining the desired gel texture
 - Observations depending on the use of the gel with different liquid foods with different characteristics and concentrations required for each one
 - Temperature range that gel can withstand before starting to melt. Information about serving temperature (between 60°C/122°F and 80°C/176°F). Description of gel's thermo-reversibility, which means whether the gel can reform after melting once the initial conditions are readjusted and conditions in which the gelling agent can improve gel formation.
- Information about gel preservation and storage conditions:
 - Duration time that gel will retain the same or similar features; description of ideal storage conditions
 - How freezing and thawing affect the flavor and texture characteristics of the gel
 - Information about the possible combinations of different texturizing agents; potential synergistic effects for the obtaining of better results or other applications
 - Possible synergies with other commonly used texturing agents that can improve the resulting gel, by providing greater stability, heat resistance, or elasticity
- When synergies with other texturing agents are able to create any different effect than the assumed

Throughout the usage instructions, we emphasize certain information with the following indications:

Recommendation: special usage advice.

Caution: potential risks associated with the process.

Useful Tip: suggestions for methods and procedures.

PRINCIPLE CULINARY PREPARATIONS PREPARED WITH GELLING AGENTS

Multiple elaborations can be made with each type of gelling agent because of variations in the hardness and elasticity of the resulting gels:

- The textures presented in the table are a random sample of different possibilities that can be achieved with a product to provide an idea of the different possibilities to be done. These are not necessarily the only textures that can be produced or the appropriate names for them. They are only examples, and they can vary depending on many different factors.
- These examples of how texturizing agents can be used provide a guideline for further experimentation. Of course, the real range of possibilities is much too great to fit into a summary table.

GELATIN

GENERAL INFORMATION

FEATURES AND USE

When gelatin is used in suitable proportions it provides a pleasantly soft texture, thanks to its ability to melt in the mouth (36°C/96.8°F). Gelatin does not require high temperatures to obtain hydration, so ingredients do not have to be subjected to cooking and its possible subsequent oxidation. Gelatin is very versatile and can be used with most ingredients. Gelatin is also very useful as a supporting agent, allowing

cooks to manipulate certain preparations (cutting, gathering, forming), with only a light application of heat needed to reverse its effects.

TERMINOLOGY

Gelatin is also known as fish gelatin, as gelatin used to be obtained primarily from fish protein and because sheet gelatin resembles the scales of a fish.

ORIGIN

Gelatin is obtained from the physicochemical extraction of collagen from animal bones and skin and is derived mainly from pigs and in a second scale from cows. Gelatin obtained from fish is also available, used mainly on certain religious alimentary prescriptions.

NATURAL PROPERTIES

Gelatin is made of animal protein.

FORMS

Powder or sheets.

LEGAL INFORMATION

Food-grade gelatin is classified as a culinary ingredient, with no limitations on use or consumption.

KEY PROPERTIES

- Gelatin is a hydrocolloid.
- Gels produced with gelatin are classified as *soft gels* and are very elastic.
- Gelatin is typically used as a gelling agent but can also be used as an emulsifying or foaming agent.

- Gelatin does not dissolve in oil.
- Pregelatinized gelatin powder can be hydrated without the application of heat.

HISTORICAL NOTES

Although the ancient Egyptians discovered gelatin, it was not until the late seventeenth century that gelatin began to be extracted from animal bones. Until recently, gelatin was used almost exclusively in Western cultures.

GENERAL APPLICATIONS

In food industry: dairy desserts, pastries, meats, product restructuring, etc.

Other uses include pharmaceutical preparations such as excipients, capsules, and tablets. Used also in the photography industry.

ADDITIONAL INFORMATION

The gelling strength of gelatin is measured in Bloom degrees. Bloom values typically range between 75 and 300, with 220 Bloom gelatin sheets being the most commonly available. A higher Bloom number corresponds with a stronger resulting gel at same dosage.

CHARACTERISTICS OF THE SELECTED PRODUCT

We tested gelatin in sheet form because it's the type of gelatin more commonly used in the kitchen. It disperses easily and does not produce an aftertaste like most powdered gelatin (depending on degree of refinement).

BASIC FEATURES

Information provided by the manufacturer.
220 Bloom per sheet
Each sheet weighs 2 grams.

NUTRITIONAL VALUE

Information provided by the manufacturer.
(European version)
Gelatin sheets consist mainly of animal protein and should therefore be avoided by people with certain dietary restrictions.

GEL PREPARATION

- 1. Add the gelatin sheets one by one in a cold water bath (use dry hands). Place over ice or in a refrigerator, and let it rest for at least 5 minutes.
- 2. Remove the gelatin sheets from the water bath, drain, and place them on a paper towel to remove excess water.

	g/100g
Carbohydrates soluble fiber	0
Protein	84.4
Fat	0
	mg/100g
Sodium	32
Potassium	22
Magnesium	11
Calcium	11

FIGURE 2.3 NUTRITIONAL VALUE OF THE GELATIN USED.

3. Add the gelatin sheets to the container of liquid to be gelled.
4. Bring the mixture to a temperature between 40°C/104°F and 50°C/122°F, until the gelatin sheets are dissolved in the solution.
5. Remove the mixture from the heat and pour into a mold or the desired container; let it cool in the refrigerator.

ABOUT GEL PREPARATION

WORKING CONCENTRATION

In kitchen use, the basic proportion is at least 4 sheets (8 g) of gelatin per liter of liquid. The maximum proportion is of 12 sheets (24 g) per liter.

The gel textures that can be obtained by applying the following concentrations of gelatin to set 1 liter of water in a mold that is 3 cm thick are the following:

- ½ to 3 sheets (8 g): low viscosity. Texture: SAUCE/SYRUP
- 4 sheets (8 g): very soft gel. Texture: THICK CREAM/CUSTARD
- 5 sheets (10 g): soft gel. Texture: JELLY/JAM
- 6–12 sheets (12–24 g): medium gel. Texture: JELLO/ASPIC
- 12 or more sheets (24+ g): firm gels. Texture: FRUIT PASTE

In rare cases, the ratio of gelatin per liter of water can be increased to 16 sheets (32 g) per liter or more depending on the characteristics of the product used and the desired result.

The hardness of the gel depends on the concentration of gelatin used and on the composition of the liquid ingredient that is to be gelled. Those are the two most important parameters to consider when optimizing the best hydration.

The same concentration of gelling agent can produce gels with different textures, because of possible evaporation of the liquid at the time of hydration or because of variations in the characteristics of the product that is to be gelled.

There is no minimum amount of liquid necessary to produce a gelatin gel, but we recommended starting with at least 100 g of liquid so that the

gelatin can be measured appropriately and can dissolve properly in the liquid. In lower quantities of liquid it is difficult to measure and handle the correct amount of gelatin, and results can therefore be altered.

PREHYDRATION OF GELATIN SHEETS

Gelatin must be prehydrated or soaked in water before use; this procedure requires a cold temperature of the water used: less than 8°C/46.4°F.

When working with a large number of gelatin sheets, we recommend using very cold water. Add the sheets to the water one at a time for better hydration and to prevent them from sticking together.

Hydrating the gelatin sheets in the liquid that is to be gelled is not recommended, as hydration may be incomplete because of different characteristics of the food.

Hydrated gelatin sheets can be kept for up to 48 hours without altering their properties considering that the water has not been contaminated by unwashed hands or other contaminants.

GEL FORMATION

A minimum temperature of 40°C/104°F is required for the dissolution of the gelatin sheets when in the solution to be gelled.

During dispersion, the temperature should be below 100°C/212°F so that the gelatin will not lose its ability to gel and to prevent the solution from changing color and becoming opaque or yellowish. Since the gelatin sheets do not require high temperatures to dissolve, take care not to overheat the liquid.

Gelatin begins to gel as the solution cools to a temperature of 10°C/50°F. The mixture obtained should be refrigerated for several hours, depending on the concentration of gelatin used and the amount of liquid to be gelled.

DISPERSION AND HYDRATION

The gel does not require strong agitation to disperse. Gentle mixing with a whisk, spoon, or other kitchen utensil is sufficient.

Since gelatin is a protein, special care must be taken when working with a whisk to avoid incorporating too much air, as foam could be created, which would be difficult to remove and could produce an undesirable texture.

The best results (in terms of texture and gel hardness) occur when all of the liquid to be gelled is heated evenly (to a temperature no higher than 40°C/104°F). High temperatures are not necessary for dispersion and incorporation of the gelatin, and mild heating will not affect the organoleptic properties of most sensitive foods (like fruit juices). However, if necessary, the gelatin can be dispersed in a small part of the total amount of liquid to gel. This mixture, after being heated and having dispersed the gelatin in it, can then be added to the rest of the liquid, which has remained at room temperature. Because gelatin takes time to form a gel, this procedure works well as an alternative.

Caution: vigorous agitation during heating can incorporate air into the mixture, which will be difficult to remove afterward.

ABOUT THE RESULTING GEL

The gelling time depends on the concentration of the gelling agent, the size and shape of the gel, and the cooling temperature. A period of three hours under the right conditions is considered sufficient for most cases regardless the aforementioned factors.

For the gel to set properly and to ensure proper food handling conditions, it should be stored in the refrigerator at a temperature below 4°C/39°F. Keep in mind that the gelling temperature is 10°C/50°F, so the gel will not stabilize correctly if stored at higher temperatures.

In our experiments we observed the previous conditions explained. An experiment was done using 1 liter of water in which 10 sheets of gelatin (20 g) were dissolved and molded in a 3 cm thick mold. As said, when the trial was left at room temperature, it only did gel after being left 3 hours in the refrigerator.

In general, we do not recommend covering or sealing the container/mold containing the warm gelatin solution. Condensation of the evaporated

water can form a film on top of the solution, which could prevent the gel from forming properly.

Because gelatin is an elastic gel, vibration and sudden movements during the gelling period do not affect the final result substantially. However, we recommended storing the solution in place where no movement or vibration can affect it to ensure a good gelling process. Be sure the container rests on the flattest surface possible to prevent the obtaining of gels of uneven thickness.

GELATIN AND VARIOUS FOODS

Gel formation is highly dependent on the characteristics of the food-stuff to be gelled and the amount of gelatin used. For example:

- If the food to be gelled contains moderate concentrations of calcium compounds, sugar, or salt, gel hardness increases slightly.
- If the liquid has a high fat content, there may be problems with the gelling process.
- If foods are acidic ($\text{pH} < 2$), the resulting gel is softer than the gel that would result from the same concentration of gelatin in a less acidic liquid. For acidic foods, it's best to use a higher concentration of gelatin.
- Strong alcoholic beverages (40%) can be difficult to gel. The proportion of gelatin to liquid must be increased. It may be necessary to reduce the alcohol concentration by adding water or syrup.

Our studies have shown that gelatin can be used to form gels with almost all the food products tested (see Annex 1).

Gelatin typically produces transparent gels, but it depends on the liquid used. Opaqueness or impurities in a gel may be caused by the presence of particles or impurities in the food product, which fall into the bottom of the forming gel during the gelling process. In addition, if the food to be gelled has a high proportion of fat or oil, water and oil phases can separate (with the oil on top and the water below).

HANDLING AND MANIPULATION OF GELATIN GELS

SERVICE

Gelatin gels begins to melt at around 30°C/86°C, but the exact temperature depends on the concentration of gelatin and the size of the gel. Logically a gel produced with lower concentrations of gelatin is less resistant to heat.

Gels should be stored in a cool place during restaurant service (less than 30°C/86°F) to prevent complete or partial melting. Handling the gel with warm hands or other objects at temperatures near 30°C/86°F should be avoided (in addition to the safe food handling considerations noted above).

Gelatin gels are reversible. When heated to 40°C/104°F, the gel melts without evaporation or loss of properties and the gel can be reformed by repeating the cooling process.

STORAGE

The shelf life of a gelatin gel depends mainly on the shelf life of the product that has been gelled. The gel should be stored in the refrigerator and should be covered with a lid to prevent: the absorption of other flavors, the possible drying, or a cross-contamination with other products. As mentioned already, the gel should not be covered until it has cooled completely.

Freezing gelatin gels is not recommended as their structure will be slightly affected. Lightly gelled preparations such as mousses or foams, however, can be frozen without any appreciable alteration in texture.

SYNERGIES WITH OTHER GELLING AGENTS

Gelatin can help give elasticity and prevent syneresis of hard gelling agents when working together with agar-agar or kappa carrageenan. The amount of gelatin added depends on the desired characteristics of the gel: more elastic or more heat resistant.

It is possible to make a gel that is both elastic and heat stable, using a formula of 5 g agar-agar and 2 sheets (4 g) of gelatin per liter of product.

MILD SHELLFISH AND VEGETABLE ESCABECHE

CARLES GAIG, RESTAURANT GAIG (BARCELONA)

SERVES 4

SHELLFISH

Ingredients

12 mussels
4 Belon 000 (large) oysters
4 sea scallops
16 cockles
4 razor clams
80 g fresh tuna
1 liter water
90 g salt
2 tablespoons soy sauce

Preparation

Add the salt to the water and bring to a boil. Once it has started, add the mussels and boil them until the shells open. Remove the mussels from the shell and set aside for later use. Discard shells. Repeat the process for the cockles and then for the razor clams. Open the oysters, being careful not to lose the liquid inside. Pour the liquid into a separate bowl for later use. Discard shells. Open the sea scallops and extract the scallops. Discard shells. Place the mussels, cockles, razor clams, oysters (without liquid), and scallops onto a heatproof pan with raised edges (to prevent loss of liquid).

GARNISH

Ingredients

8 green asparagus heads
8 snow peas
1 radish
Purple shiso

Preparation

Place the snow peas in boiling water for 1 to 2 minutes until al dente.

Remove and repeat process for green asparagus heads.

Cut the radish into fine slices. Chop purple shiso into thin slivers.

ESCABECHE

Ingredients

1 baby carrot
2 shallots
½ leek
2 garlic cloves
300 ml sunflower oil
100 ml Cava vinegar
Salt
2 bay leaves
Pink peppercorns
Black peppercorns

Preparation

Clean and dice vegetables.

Place the vegetables in a saucepan with the sunflower oil. Heat over medium-high heat until the oil begins to sizzle. Turn the heat down and leave to cook for 10 minutes.

Add some pink and black peppercorns, salt, 2 bay leaves, and the Cava vinegar. Cook over low heat for 10 minutes more. Remove from heat and immediately pour over the shellfish.

Place the pan with the shellfish and escabeche in the refrigerator and chill for at least 6 hours before serving. The mixture can be refrigerated at 3°C for up to 48 hours before serving.

OYSTER GELATIN**Ingredients**

50 g of the reserved oyster liquid

50 g Cava

1½ gelatin sheets (3 g)

Preparation

Mix the reserved oyster water with the Cava in a pan. Soak the gelatin in cold water until well hydrated. Add the hydrated gelatin to the pan. Heat mixture over medium low heat, stirring gently, until the gelatin is melted. Remove from heat and place in the refrigerator until mixture solidifies.

Cut the resulting gel into 1 × 1 × 1 cm cubes. Refrigerate until ready to serve.

Dice the fresh tuna into 1 × 1 × 1 cm cubes. Marinate the cubes in the soy sauce for 1 minute.

Place the shellfish and the vegetables on a serving dish. Dress the seafood and vegetables with the escabeche. Add the marinated tuna and the gelatin cubes to the dish.

Serve cold.



(a)



(b)

FIGURE 2.4

AGAR-AGAR

GENERAL INFORMATION

FEATURES AND USE

Agar-agar gels produce heat-resistant gels. Thus, it was used to create the first *hot jello*. This property also allows chefs to create gels that are served cold or at room temperature but that are able to withstand the high temperatures of the kitchen, permitting an easier planning and preparation. Agar-agar is also a very versatile product that works with most of the usual kitchen ingredients.

TERMINOLOGY

Agar-agar is also known as kanten.

ORIGIN

Agar-agar comes from the cell walls of various red algae belonging to the genera *Gelidium* and *Gracilaria* and is extracted with a chemical treatment.

NATURAL PROPERTIES

Agar-agar is a carbohydrate polymer.

FORMS

Red algae filaments (widely used in Asian cuisine). Refined powder.

LEGAL INFORMATION

In Europe, agar-agar is designated as an additive. The EU food additive code for agar-agar is E-406.

KEY PROPERTIES

- Agar-agar is a hydrocolloid.
- Agar-agar is used as a gelling agent.
- Agar-agar disperses in cold water and hydrates in hot water. It does not dissolve in oil.
- The resulting gels do not melt in the mouth (at body temperature).
- The resulting gels are fragile and brittle, with little elasticity.

HISTORICAL NOTES

The first documented use of agar-agar was in 1658 in Japan: its gelling effect was discovered by accident when boiling red algae. Its use spread throughout the East in the seventeenth and eighteenth centuries but did not reach the West until 1859, with the arrival of Chinese food. Agar-agar began to be used in the food industry during the twentieth century. It was not widely used in fine dining restaurant kitchens until 1998, when the restaurant elBulli began experimenting with agar-agar using it to make heated gels.

GENERAL APPLICATIONS

In the food industry: confections, canned vegetables, meat products, ice cream, cheese, soups, among others.

Other applications: in science research as a solid medium for growing microorganisms.

ADDITIONAL INFORMATION

In Japan agar-agar is labeled as an ingredient, but in most countries it is considered to be a food additive.

CHARACTERISTICS OF THE SELECTED PRODUCT

The product we chose to work with is one of the finest available. It leaves little residual seaweed flavor compared with other types of agar-agar. In many cases, depending on the flavor intensity of the food

with which you are working, agar-agar can add a light aftertaste to the resulting gel.

BASIC FEATURES

Information provided by the manufacturer
Particle size distribution (ASTM), <10% retained, 60 mesh
Gel strength (Nikken) 600–750 g/cm², before autoclaving
Moisture, < 20%
Ash, < 5%
pH = 6–7.5 in a solution of 1.5%, gel before autoclaving
Gelling temperature, 33–36°C/91.4–96.8°F

NUTRITIONAL VALUE

Information provided by the manufacturer
(EU Version)
There are no known restrictions on the use of agar-agar. It is a vegetarian alternative to gelatin.

PREPARATION OF AN AGAR-AGAR GEL

1. Add the agar-agar to the liquid you want to gel, which should be cold or at room temperature.

Energy kcal/100g	720-172
	g/100g
Protein (N×6.25)	< 0.1
Carbohydrate total	0.4
Fibre	86
Fat	< 0.1
Sodium	0.5

FIGURE 2.5 NUTRITIONAL VALUE OF THE AGAR-AGAR USED.

2. Mix well with whisk.
3. Place the mixture in a saucepan and bring to a boil, stirring constantly.
4. Remove from heat once the mixture starts to boil and remove possible foam formed.
5. Pour the mixture into the desired mold and let cool in the refrigerator.

ABOUT GEL PREPARATION

WORKING CONCENTRATION

The basic working concentration for food preparation is between 0.2% and 1.5% of agar-agar.

For example, the following list outlines approximate gel textures that can be obtained by applying the following concentrations of agar-agar to set 200 g of water in a 3 cm thick mold:

- Less than 0.2% gives a low viscosity gel. Texture: SAUCE/SYRUP
- 0.2% produces a very soft gel. Texture: THICK CREAM/CUSTARD
- Between 0.3% and 0.5% provides a texture of medium gels. Texture JELLY/JAM
- Between 0.5 and 0.8% gives a texture of firm gels. Texture JELLO/ASPIC
- Greater than 0.9% the texture obtained is as hard gel. Only consumable when cut thin.

The hardness of the gel depends on the concentration of the gelling agent used as well as the composition of the liquid food. These are the two most important parameters for optimal hydration.

Identical concentrations of a gelling agent can produce gels with different textures because of the possible evaporation of the liquid at the time of hydration of the mixture or depending on the origin of the product that is to be gelled.

There is not a minimum amount of liquid necessary for agar-agar to gel, but boiling the liquid is necessary for agar-agar to be completely hydrated. This means that the possible evaporation of the liquid to gel must be taken into account when boiling. Therefore,

we recommend working with a minimum of 100 g of liquid to avoid variations in the hardness of the final gel. With less liquid, it is difficult to control the evaporation, and the resulting gels may suffer from texture irregularities.

WORKING TEMPERATURES

Agar should be hydrated with cold or room temperature liquid to avoid clumping, which can occur with premature heating. Strong mechanical agitation is not required for good dispersion—a hand whisk will suffice.

If the agar-agar once diluted does not maintain a minimum temperature of 80°C/176°F for at least 5 minutes, the hydration will be incomplete and the gel will not form properly. The surest way to hydrate the agar is to bring the mixture to the boiling point and then remove it from the heat. This assures that the mixture will reach the proper temperature and that the agar-agar will become fully hydrated.

Caution: Even if the agar-agar doesn't lose its gelling properties, prolonged exposure to boiling liquid can cause excessive evaporation, which can produce an undesirably hard gel. For this reason, it's best to remove the mixture from the heat after it reaches the boiling point for the first time.

Dispersion/Hydration

If the temperature of the liquid is above 60°C/140°F when the agar-agar is added to it, the hydration process will start before the agar-agar disperses and clumping will result. Therefore, we recommend adding the powdered agar-agar to a liquid when it's below 60°C/140°F.

During the heating process, the solutions should be stirred constantly to prevent any agar-agar from precipitating to the bottom of the container, where it can get stuck and therefore not act properly as a gelling agent.

It's best to heat all of the liquid that is to be gelled, as the resulting gel will form better. If less than 50% of the product is heated, the hardness of the final gel might suffer variations.

When dealing with delicate products or products that can lose their fresh flavor when heated, we recommended heating only half of the agar-agar solution and once it's cooled mixing it with the other half,

which is at room temperature. This procedure will help preventing the loss of the organoleptic properties of the original ingredients.

Useful Tip: the best way to avoid lumps and clumping of the agar-agar in solution is to add the agar-agar to other dry ingredients being used in the recipe. For example, if using sugar mix the gelling agent with part of the sugar and then gradually add the mixture to the liquid that is to be gelled.

ABOUT THE RESULTING GEL

Agar-agar gel begins to gel at high temperature, so the process of gelling occurs relatively quickly compared with gelatin. Varying the concentration may yield different gelling temperatures, but in generally agar-agar starts to gel at 40°C/104°C and finishes at of 25°C/77°F. Therefore, the gels can form at room temperature, but for reasons of convenience and food safety refrigeration is best.

The following results were observed when working with agar-agar and water. A solution of 1% agar-agar in water placed in a 3 cm mold requires the following approximate times to form a gel:

- In refrigeration or 4°C/39° F: 35 minutes
- At room temperature or 18°C/64.4°F: 90 minutes

The time required for the agar-agar to gel depends on the concentration used and the volume of the liquid as well as the ambient temperature in which has been settled down. Gel formation will be faster at higher concentrations of agar-agar and when the desired gel has less depth. For example, a thin sheet-like gel forms much faster than a gel that is in a deep container.

Recommendation: To avoid cross-contamination and microbial growth, it's best to store the solution in the refrigerator as it gels.

Caution: During the gelling process, it is best not to cover the solution while it is hot. Condensation from evaporated water can form a layer on top of the solution that may cause defects in the resulting gel.

Agar-agar gels are thermo-reversible, so it is possible to modify the concentration of the gelling agent used if the initial gel is not formed as expected, although the final texture may vary slightly due to the evaporation that occurs when the solution is boiled a second time.

If the gel is agitated or is subjected to sudden movements while gel formation is occurring, the gel structure may break, and the resulting gel may have irregularities and undergo syneresis (loss of water).

For this reason, the solution should be placed in a stable location on a flat surface without movement or vibration while the gel forms.

AGAR-AGAR AND SPECIFIC FOODS

The formation of an agar-agar gel depends on the characteristics of the food to be gelled and the proportion of agar-agar used. For example:

- The gel will not form in very acid ($\text{pH} < 2$) environments, such as when agar-agar is mixed with pure lemon juice. It is possible to obtain a gel by increasing the proportion of agar-agar, but the gel will have a soft texture and will leave after an aftertaste in the mouth. Correcting the acidity of the lemon juice by adding something like sugar syrup would be a better approach for obtaining a satisfactory gel.
- Agar-agar gels are slightly less hard in the presence of high calcium concentrations.
- Agar-agar gels cannot form in the presence of oil, even with a proportion of 50% oil and 50% water.
- High alcoholic drinks (40°) may have difficulty gelling, but increasing the proportion of agar-agar or diluting the alcohol concentration with water or syrup can resolve this issue.

In our experiments with how agar-agar behaves with various food products, we found that the agar-agar gels can be formed with most of the products that we studied (see Annex I).

Impurities or opaqueness in an agar-agar gel may be due to the following:

- Foam or bubbles, formed by the incorporation of air during the mixing process or during the boiling process, that have not been properly removed
- Particles of the food product or other impurities that remain on the surface as the gel forms

- The food product containing a high proportion of fat or oil, with an unavoidable separation into two phases, with the resulting aqueous phase situated on the bottom and the liquid phase situated on top of the gel

HANDLING AND MANIPULATION OF AGAR-AGAR GELS

SERVICE

Agar-agar gels are served hot and can withstand temperatures up to 85°C/185°F. The temperature that the gel can tolerate depends on the amount of agar-agar and the size of the gel—obviously a lower concentration of agar-agar has less heat resistance. The volume of the gel influences its resistance to higher temperatures as well.

Agar-agar gels are reversible, which means that if the gel has a problem of formation or irregularity, it can be brought to a boil and regelled. This practice is not recommended except in cases of necessity as the reformed gel is usually different from the original because of excess evaporation during heating and relatively weakening of the structural capacity of agar-agar. **Caution:** Evaporation should always be monitored, as a significant loss of water will alter the concentration of the gel and affect the final texture. If that happens, mineral water can be added to restore the initial volume regardless of the type of product with which you are working.

STORAGE

The shelf life of an agar-agar gel depends mainly on the shelf life of the product that has been gelled. The gel should be preserved in the refrigerator and covered with a lid (once the gelling process is complete) in to prevent absorption of other flavors, drying of the gel, or cross-contamination. **Useful Tip:** When serving the gel, if only a portion of it is needed we recommend cutting only those portions necessary to avoid excessive syneresis and surface drying.

Agar-agar gels cannot be frozen and thawed. The process can break the gel structure and cause syneresis in addition to producing an undesirable appearance.

SYNERGISTIC EFFECTS WITH OTHER GELLING AGENTS

To improve an agar-agar gel, it can be combined with gelatin. As indicated earlier in the section on gelatin, this combination gives elasticity to the gel formed with the gelatin while maintaining the high temperature resistance of the agar-agar.

COD, ALMOND, AND WILD MUSHROOM SOUP

CARME RUSCALLEDA, RESTAURANT SANT PAU

(SANT POL DE MAR, BARCELONA)

SERVES 4

BROTH BASE**Ingredients**

2 liters mineral water
175 g onions cut into strips
175 g carrots, peeled and cut into strips
175 g leeks cut into strips
Small bunch of parsley
Several bay leaves
Salt

Preparation

Bring the water to a boil.
Add all of the vegetables and the herbs.
Season broth with salt to taste and cook for 20 minutes on medium heat.
Strain broth and set aside.

COD SOUP**Ingredients**

250 g of cod, skin and bones included
75 g sliced almonds

20 g parsley cut in brunoise
15 g garlic, cut in brunoise
75 ml extra virgin olive oil
1.7 liters vegetable stock, heated

Preparation

Cut the fish into small strips and then fry it lightly in a pan with oil. Add the garlic and the almonds and season gently with salt and pepper (the cod is already salted). Cook until lightly browned and then add the parsley.

Add the hot broth and cook for 3 minutes on medium heat.

Blend the soup finely in a Thermomix or blender. Strain soup through a metal colander and set aside.

MARZIPAN ASPIC

Ingredients

200 ml mineral water
100 g almond flour
200 ml extra virgin olive oil
50 ml cream
2 g garlic, peeled and sliced
1 g agar-agar
12 g sheet gelatin
Salt
White pepper

Preparation

Fry the garlic lightly in a pan with oil. Add the water, cream, and almonds and mix well.

Blend the mixture with an electric blender until smooth. Add the agar-agar and cook for 1 minute.

Remove from heat. Add the gelatin (which has been previously soaked in water). Season mixture with the salt and pepper to taste, and place it in a 10 cm x 14 cm container to set.

Once the aspic is set, cut it into 2.5 cm x 2.5 cm squares, and then cut the squares in half diagonally to obtain triangles.

Cod**Ingredient**

200 g piece of cod, desalted

Preparation

Freeze the cod and cut into 3 mm slices.

Make neat squares and then cut the squares into triangles that are the same size as the squares of aspic. Set aside.

WILD MUSHROOMS**Ingredients**

100 g varied wild mushrooms, cleaned and cut into strips

50 g almonds, fried

Chopped wild leek

Preparation

Place the cod triangles on a baking tray lined with parchment paper.

Place the marzipan aspic triangles on top of the cod, with a drop of olive oil. Bake at 190°C/374°F for 1 minute.

Remove from the oven and place another triangle of cod on top of each hot triangle. Sprinkle with oil and place under the salamander stove.

Meanwhile, stir-fry the mushrooms with the chopped wild leek.

Distribute the almonds and fried mushrooms on warm plates, and then place two pieces of hot cod-marzipan on top. Serve the soup very hot at the table in front of the diners.

THE RESULTING DISH

This is a creamy, perfumed soup. The almonds and mushrooms marry well with the cod. The cod is the protagonist of this dish: it flavors the soup, brings a savory touch to the hot marzipan aspic, and is also present in an almost raw, laminated texture.



FIGURE 2.6 COD, ALMOND AND WILD MUSHROOM SOUP.

SODIUM ALGINATE

GENERAL INFORMATION

FEATURES AND USE

Sodium alginate is used mainly for the technique known as spherification, but it is also used for its thermoirreversible properties—it is capable of forming gels that do not melt even at the highest temperatures.

The technique of spherification and its variations permits the creation of many new dishes and many creative possibilities.

TERMINOLOGY

Sodium alginate is also known as the sodium salt of alginic acid.

ORIGIN

Sodium alginate is extracted from brown algae (e.g., *Macrocystis*, *Fucus*, *Laminaria*, *Ascophyllum*) found in cold-water oceans.

NATURAL PROPERTIES

Sodium alginate is an organic salt derived from polysaccharides from the cell walls of brown algae.

FORMS

Powder.

LEGAL INFORMATION

Sodium alginate is classified as an additive in Europe. The EU code for sodium alginate is E-401.

KEY PROPERTIES

- Sodium alginate has the properties of a hydrocolloid.
- It can be used as a gelling agent, a thickening agent, and in some cases a stabilizer.
- Hydration can be performed in both hot and cold aqueous mediums but not with oil or other fats.
- Sodium alginate can form a gel without the application of heat, but calcium salts must be present in the medium for gelling to occur.
- Gels formed with the addition of calcium salts are thermoirreversible and do not return to a liquid state when heated.

HISTORICAL NOTES

Although there is evidence of the use of brown algae in the kitchen of the Roman Empire as well as in China, it was not until 1881 that the alginates could be isolated from the rest of the algae and used on its own. The English chemist E. C. C. Stanford was the first to achieve this technique, and he named the gelatinous compound *algin* after the brown algae from which it came.

In 1929 the Kelco Company in California began industrial production, followed by one in Britain in 1934 and then in Norway, France,

and Japan. In 2003, the restaurant elBulli began using alginate in the kitchen.

GENERAL APPLICATIONS

Applications for the food industry: many applications, especially for the restructuring of food products to improve appearance and texture, such as used in surimi derivatives.

Other examples include canned vegetables and ice cream formulations.

Other applications: pharmaceutical products.

ADDITIONAL INFORMATION

There are a great variety of commercially available sodium alginates, which produce different organoleptic characteristics, average viscosities, and gelling abilities, among other properties. The properties of each resulting product vary according to the manufacturer's guidelines and their intended uses.

CHARACTERISTICS OF THE SELECTED PRODUCT

The product that was tested produces a medium viscosity solution and has a strong gelling capacity. It is easy to work with and can be used for spherification. This product leaves very little residual taste in the finished dish.

BASIC FEATURES

Information provided by the manufacturer.

- Particle size: at least 90% of particles are smaller than 200 microns (ASTM screen No. 70) and at least 99% of particles are smaller than 500 microns (ASTM screen No. 35).
- Evaporation loss is not above 15%.
- pH range: 6 to 8.5—measured in a 1% aqueous solution.

Energy kcal/100g	0
	g/100g
Total Carbohydrate	0
Fibre	63
Fat	0
	mg/100g
Sodium	9300
Potassium	800
Iron	1

FIGURE 2.7 NUTRITIONAL VALUE OF THE SODIUM ALGINATE USED.

- Rheological properties: break strength of gel in water: 500–700 g, measured at 20°C/68°F on a penetrometer (distance 20 mm.). Viscosity in a 1% aqueous solution: 150–300 cps measured at 20°C/68°F, on a Brookfield RV viscometer spindle N1, 20 rpm.

NUTRITIONAL VALUE

Information provided by the manufacturer.
(European version)

There are no known restrictions on use. It is a vegetarian alternative to gelatin.

INSTRUCTIONS FOR USE

PREPARATION OF A SODIUM ALGINATE GEL

Since sodium alginate forms thermoirreversible gels, it can be used to create gels that will not melt even at very high temperatures. Its most common use, however, is for the technique known as *spherification*, which refers to the controlled gelling process of a liquid within another liquid.

There are two basic methods of spherification: *basic* (also known as direct) and *reverse* (also referred to as spherification-I). Although different calcium salts are available on the market, two are typically used: calcium chloride as a calcium source for the sodium alginate to gel; and calcium gluconolactate for the reverse method (because it does not alter the flavor of the food).

Both methods are useful in different situations. Deciding which one to use depends on the desired final result and how it fits within a dish or menu.

Method A: Basic Spherification

The sodium alginate is mixed with the food product, which must be free of calcium and nonacids to permit correct gelation and then introduced into a water bath enriched with calcium. This procedure results in the formation of spheres with gelled, elastic, and resistant outer layers surrounding liquid interiors that burst in the mouth. The procedure is as follows:

1. Mix the alginate in the liquid that is to be gelled and stir vigorously with a handheld electric mixer until there are no lumps. Let stand for at least 30 minutes in the refrigerator to allow proper hydration of the alginate. Any excessive air incorporation that can form during the mixing can be eliminated by a resting period or with the aid of a vacuum packaging machine.
2. Dissolve the calcium (calcium chloride or calcium gluconolactate) in room temperature water by mixing with a spoon. The water temperature at the time of dissolution does not affect the subsequent result.
3. Gently pour the alginate/product mixture into the calcium bath with the help of a semicircular spoon until spheres reach desired size. Different sized syringes may also be used, and specialized tools are even available for this purpose.
4. Let the mixture stand for at least 2 minutes and no longer than 5 minutes (depending on the size of the spheres), and then use a slotted spoon to remove the spheres from the liquid.
5. Wash spheres in a clean, cold water bath and dry them slightly with paper towels. Serve immediately.

Caution: The gelling process cannot be stopped once it begins, so the resulting spheres must be served immediately before the spheres completely gel on the inside. The lifespan of a 2 cm diameter sphere is about 10 minutes in good conservation conditions. After 10 minutes, the gelled outer wall becomes too thick, and the organoleptic properties become suboptimal.

Method B: Reverse Spherification

The food product is enriched with calcium (if it is not already naturally calcium rich) and is then introduced into a water bath containing sodium alginate, producing gelled spheres with liquid centers. Because of the high density of the sodium alginate bath, the food product used must be thick. In many cases xanthan gum or other thickeners are added to facilitate their immersion of the food product in the bath.

1. Mix the alginate with room temperature water by applying strong agitation with a handheld electric mixer until there are no lumps. Let the mixture stand in refrigerator for at least 30 minutes to allow adequate hydration of the alginate.
2. Use a whisk to mix the liquid that is to be gelled with the calcium gluconolactate. Add the xanthan gum and mix well with a handheld electric mixer trying to avoid the incorporation of air. (The addition of xanthan gum is necessary only when working with very low viscosity liquids.)
3. Gently pour the calcium-enhanced liquid into the alginate water bath interior with the help of a semicircular spoon, and let it stand for at least 2 minutes (depending on the size of the sphere). During the gelling process the spheres shouldn't touch, as they may stick to one another by the nature of the process.
4. Remove the spheres from the bath and wash them with a clean room temperature water bath. Dry them slightly and serve or store them in the refrigerator within a liquid or a fat until service time because in that case gellification process will not keep going as in the basic spherification method does.

Useful Tip: To create shapes other than spheres, gelatin (6 sheets (12 g)/liter) can be added to the calcium-rich liquid in the spherification-I

method, following the method for preparing a gelatin gel. Once firm, the resulting gel can be cut into desired shapes.

Just before serving, gently heat the shapes to melt the gelatin to obtain a liquid texture on the inside of the gelled shapes. This technique is called *molded spherification*.

ABOUT GEL PREPARATION

WORKING CONCENTRATION

For Method A: Basic Spherification

The basic ratios used are as follows:

- Sodium alginate: 0.5–0.8%
- Calcium chloride: about 0.5–0.6%

The result: the obtained spheres have liquid centers that burst in the mouth—spherification.

For Method B: Reverse Spherification

The basic ratios are as follows:

- Sodium alginate: 0.5%
- Calcium gluconolactate: 0.5–2%
- Xanthan gum: 0.2–0.5%

The result: the obtained spheres have smooth exteriors and are slightly viscous on the inside—spherification.

Sphere hardness depends on the concentration of the gelling agent used as well as the initial state of the liquid food. Both of these factors can affect the shape of the resulting sphere.

For both methods, there is no minimum amount of liquid to mix with the calcium salts, but 150 g is necessary for good dispersion and subsequent hydration of the sodium alginate (and xanthan gum, if used). This is because a handheld electric mixer must be used. For larger quantities you can also use a blender or Thermomix to expedite the task.

On the other hand, we recommend working with the minimum quantity of liquid to conveniently obtain the spheres. Use the minimum volume necessary for the spheres to be fully submerged in the bath and to have time to gel properly.

WORKING TEMPERATURES

For Both Method A (Basic Spherification) and for Method B (Reverse Spherification)

Both methods require a certain temperature for the proper dispersion and hydration of the sodium alginate as well as the other products involved in the spherification process such as the calcium salts and xanthan gum (see section on working with xanthan gum).

Although hot or cold water can be used to hydrate sodium alginate, working at low temperatures is best recommended to avoid the loss of volatile food compounds during gelling and therefore preserving the organoleptic properties of the food.

Once the gel has formed, we recommend storing it in low temperature conditions to maintain the freshness of the food and to avoid potential health risks. This procedure and conservation conditions will always depend on the product to gel and the results to achieve.

DISPERSION/HYDRATION

For Both Method A (Basic Spherification) and Method B (Reverse Spherification)

Sodium alginate requires strong agitation for good dispersion and consequently good hydration. This is best accomplished with a handheld electric mixer or with a blender when working with larger amounts.

As mentioned in the previous section, sodium alginate disperses in cold liquids but obtains better dispersion in hot liquids. As stated already, when working with fresh foods with delicate flavors working in low temperature conditions is strongly recommended.

To avoid lumps, add the alginate slowly to the liquid that is to be gelled. After agitations refrigerate the mixture for 30 minutes so that full hydration can occur.

Useful Tip: When method A (basic spherification) is applied and when working with recipes that use sugar, we recommend first mixing the sugar with the alginate powder, as this significantly improves the dispersion of the powder in the liquid and helps to prevent possible clumping.

Caution: With making spheres with method B (reverse spherification), calcium-enriched liquid that is added to the alginate bath must be sufficiently viscous to obtain immersion in the alginate bath (which is always more viscous than water).

Products with lower viscosity (i.e., liquids that have a texture similar to water) remain on the surface of the alginate bath, preventing the desired results. We recommend adding xanthan gum or other thickener to the liquid that is to be gelled to increase its viscosity. The goal is to match the viscosity of the liquid with the sodium alginate mixture so that the spheres sink into the alginate bath and form properly.

ABOUT THE OBTAINED GEL

FOR METHOD A (BASIC SPHERIFICATION)

The spheres that are obtained with basic spherification need a specific time to gel, depending on the size:

- Small spheres (caviar type): 2 minutes
- Regular spheres (2 cm diameter): 2–3 minutes
- Large spheres (egg type): more than 5 minutes and up to 15 minutes in some cases

FOR METHOD B (REVERSE SPHERIFICATION)

With reverse spherification the gelling time is slightly longer and especially depends on the type of food product used (according to the food's calcium content) and the desired size of the spheres:

- Small spheres (caviar type): 2 minutes
- Regular spheres (2 cm diameter): 3–4 minutes
- Large spheres (egg type): more than 5 minutes, although it is not advisable to make larger spheres because the gelled outer layer may not be strong enough to hold the shape and the sphere may become flattened by the weight of the liquid inside

With both methods, keep in mind that foods with a high fat or alcohol content require longer gelling times to form a strong enough outer layer to maintain the shape of the sphere.

Although the spheres are very elastic and porous, they cannot withstand too much pressure, and the outer membranes can easily break, releasing the liquid inside.

Caution: With small spheres, when performing reverse spherification inside the alginate bath, special care must be taken so that the spheres do not touch one another or they will stick together, unable to be separated again without breaking. This is because the gel membrane moves as it grows, thanks to the gelling process that occurs between the sodium alginate and the calcium source.

Because of this tendency, caviar-size spheres are very difficult to make using this technique.

While the spheres are within the alginate bath is very important not to disturb the mixture to prevent them from moving and sticking together.

Useful Tip: With both methods, because the outer membrane is elastic and the center of the spheres is liquid solids can be introduced into the spheres and will remain suspended in the liquid. This allows for the addition of a second flavor or texture to the final product.

BEHAVIOR OF SODIUM ALGinate WITH VARIOUS FOODS

As mentioned, sphere formation depends on the characteristics of the food products as well as the proportions of calcium and sodium alginate used.

WITH METHOD A (BASIC SPHERIFICATION)

- In an environment with excess calcium or salt: sphere formation does not occur, because proper hydration of the alginate is impeded.
- In an environment with alcohol: resulting gel is harder and does not work in all cases, especially in liquids with high alcohol content (40%).
- With oil: sphere formation does not occur, even in a solution with a proportion of 50% oil and 50% water.
- With acid foods ($\text{pH} < 2$): sphere formation does not occur because the sodium alginate does not hydrate initially.

Caution: when working with a very low pH medium, sodium citrate concentrations of 0.3% to 0.5% may be used to make the food less acid without substantially changing its organoleptic characteristics. Only small changes in pH give acceptable results, such as changing from a pH of 2 to a pH of 3. The excess sodium citrate that would be required to change the pH from 2 to 4 would be enough to affect the final taste of the food.

WITH METHOD B (REVERSE SPHERIFICATION)

Almost any food product can be gelled using reverse spherification:

- Liquids with high alcohol contents (40%) can be difficult because the alginate acts only on the water and not on the alcohol. The spheres tend to remain on the surface and don't form correctly. It is advisable to mix the liquid with other ingredients reduce the alcohol content and improve spherification.

We tested the behavior of the sodium alginate with various food products and have concluded that sodium alginate can be used to form spheres with most foods following this technique (see Annex 1, Method A).

If there are impurities and opacity in a sodium alginate sphere, this can be due to the following:

- Bubbles resulting from air incorporation during the mixing process and that have not been successfully removed
- Particles or impurities from the food product itself

HANDLING AND MANIPULATION OF SODIUM ALGinate GELS

SERVICE

Both for Method A: Basic Spherification and Method B: Reverse Spherification

Alginate beads can be served hot or cold, except in the case of molded spherification, which should be served at a warm enough temperature to prevent the gelling of the gelatin, as previously mentioned.

Although the gels obtained through the spherification process are thermoirreversible, the spheres can withstand temperatures only up to approximately 80°C/176°F. If the liquid within the spheres reach the boiling point, the gelled outer membrane will break because of the pressure. We recommend heating the spheres in a liquid that has a temperature of about 80°C/176°F when the spheres are to be served hot. This is a safe temperature to work with that will guarantee the integrity of the spheres while ensuring that they are still hot when reaching the dinner table (approximately 50–60°C/122–140°F).

STORAGE

For Method A: Basic Spherification

The spheres produced using this technique should be served immediately; otherwise, the gelling process continues until the spheres fully harden. The reaction that occurs between the sodium alginate and the calcium will continue until the center of the sphere is completely gelled and hard.

The recommended serving time is no longer than 10 minutes after the spheres have been removed from the calcium bath and subsequently washed in water. This can be a limiting factor for using the basic spherification technique when serving a large number of guests. In that case, a buffet format is recommended.

Method B: Reverse Spherification

Spheres made using this technique can withstand a longer storage period. The gelling process stops once the spheres are removed from the alginate bath and subsequently washed. The reaction of the calcium with the alginate stops because there is no more alginate in the medium, as the interior of the sphere does not contain alginate.

Storage time depends mainly on the properties and the shelf life of the food with which the spheres are made. For example, yogurt spheres must be kept cold at all times, while spheres made of sweet wine can withstand longer periods at room temperature and can last a long time with a proper maintenance.

Useful Tip: Spheres should be stored in a neutral vegetable oil such as sunflower oil or corn oil for best results as the liposoluble liquid does not interfere with the hydrosoluble membrane of the spheres. This method will prevent liquid exchange between the sphere and the medium in which they are kept, as the gelled outer membrane is porous and would allow the absorption of hydrosoluble liquids into the interior of the sphere. If the spheres are stored in water, they will absorb the water and the flavor of the interior liquid will become diluted. This is recommended only when the spheres are stored in the same liquid from which they were produced; for example, you can store cream spheres in cream.

Both alginate baths and calcium baths can be refrigerated several days and can therefore be prepared in large quantities and used as needed for each service. We do not recommend reusing alginate baths, as any leftover food source can become source of contamination for the new spheres.

Sodium alginate spheres cannot withstand freezing and thawing. The gelled membrane breaks down and syneresis occurs. On the other hand, if the food product contains hydrated alginate prior to spherification, it can be frozen without losing any of its technological properties such as gelling ability and organoleptic traits. You can therefore use reverse spherification on a water base containing sodium alginate that has been frozen, and you can likewise use basic spherification on frozen foods containing sodium alginate.

SYNERGISTIC EFFECTS WITH OTHER GELLING AGENTS

Sodium alginate does not have any special synergy with other texturing agents that can improve spherification or its functionality apart from those mentioned earlier in the chapter that provide viscosity or modify the pH of the food product to obtain better results.

SPHERICAL-I GREEN OLIVES (CATALOG NUMBER 1095)

ALBERT ADRIÀ, TICKETS AND 41° RESTAURANTS (BARCELONA)

SERVES 10

SODIUM ALGINATE SOLUTION**Ingredients**

1.5 kg water

7.5 g sodium alginate

Preparation

Mix the water and the sodium alginate with a handheld blender until the mixture is free of lumps.

Leave it to stand in the refrigerator for 48 hours until the air bubbles disappear and the sodium alginate is completely rehydrated.

GREEN OLIVE JUICE**Ingredient**

500g green Verdial olives

Preparation

Remove the pits from the olives.

Blend the olives in a blender or food processor.

Strain the purée through a fine mesh strainer (e.g., a Superbag), pressing the mixture through.

Refrigerate the juice.

SPHERICAL-I GREEN OLIVE BASE**Ingredients**

200 g green olive juice (previously prepared)

0.75 g Xantana (xanthum gum)

1.25 g calcium chloride

Preparation

Add the calcium chloride to the olive juice and leave for 1 minute to hydrate well.

Mix with a whisk and sprinkle the Xantana over the surface.

Mix with a handheld blender at medium speed.

Refrigerate for 24 hours.

AROMATIZED OLIVE OIL**Ingredients**

4 cloves of garlic

500 g extra virgin olive oil

Zest of 4 lemons

Zest of 4 oranges

4 sprigs of fresh thyme

4 springs of fresh rosemary

12 black peppercorns

Preparation

Lightly crush the garlic cloves and fry them in 100 g of olive oil, without allowing them to brown.

Add the remaining oil and wait for it to heat up before adding the rest of the ingredients.

Store the oil in an airtight container in a cool, dry place.

SPHERICAL-I GREEN OLIVES**Ingredients**

Spherical-I green olives base (previously prepared)
Sodium alginate solution (previously prepared)
Aromatized olive oil (previously prepared)

Preparation

Fill a 5 ml measuring spoon with the spherical-I green olive mixture. Drop the contents of the spoon into the sodium alginate solution to form spherical olives. Make 2 olives per person. Do not allow the olives to touch one another, as they may stick.

Leave the olives in the sodium alginate solution for 2½ minutes.

Remove the olives from the sodium alginate solution using a slotted spoon and dip them in cold water to rinse them.

Carefully strain the olives and place them in the aromatized oil without letting them touch one another.

Refrigerate for 12 hours.

EXTRAS

2 glass olive jars

FINISHING AND PRESENTATION

Put 1 piece of lemon zest, 1 piece of orange zest, 1 sprig of thyme, 1 sprig of rosemary, and 4 black peppercorns into each jar.

Divide the 20 spherical olives between the 2 jars.

Cover with the aromatized oil.

Serve each jar on a piece of slate accompanied by one slotted spoon per jar and as many medicine spoons as guests.



FIGURE 2.8 SPHERICAL-I GREEN OLIVES (CATALOG NUMBER 1095)

KAPPA CARRAGEENAN

GENERAL INFORMATION

FEATURES AND USE

The main feature of kappa carrageenan gels is that they permit rapid gelling. Kappa carrageenan gels form almost instantaneously, which allow much shorter preparation times than using other gelling agents. Kappa carrageenan produces highly translucent gels with no aftertaste, as long as the natural characteristics of the ingredients to be gelled are taken into consideration.

TERMINOLOGY

Kappa carrageenan.

ORIGIN

Kappa carrageenan is extracted from red algae (*Rhodophyta*) cell walls (*Gigartina*, *Chondrus*, *Furcellaria*, and *Euchema*) through physical and chemical processes.

NATURAL PROPERTIES

Kappa carrageenans are fibrous polysaccharides.

FORMS

Powder, and in a seaweed known as Irish moss (*Chondrus crispus*).

LEGAL INFORMATION

Kappa carrageenan is considered an additive in Europe. The EU Code for carrageenan is E-407.

KEY PROPERTIES

- Kappa carrageenan has the properties of a hydrocolloid.
- It is used as a gelling agent and as a stabilizer.
- It disperses in cold water but hydrates in hot water and does not dissolve in oil.
- It forms gels that are somewhat resistant to heat.
- It forms hard gels.
- Gelling is thermoreversible (depending on temperature the liquid to gel appears or not as a gel or as liquid state, being able to be at one or other as many times as temperature changes).
- One of the most important features of kappa carrageenan is the speed of gel formation as the solution cools, allowing the creation of unique dishes as detailed later in this chapter.

HISTORICAL NOTES

Red algae can be found on the Atlantic coasts of Europe and South America as well as the coasts of the Philippines and Indonesia. The word *carrageenan* comes from the name of an Irish village where red algae (Irish moss) have been used as food and for medicine since the Middle Ages. Industrial production of carrageenan as a gelling agent and thickener began in the twentieth century.

GENERAL APPLICATIONS

In the food industry: chocolate smoothies, low-calorie jams and jellies, dairy desserts, ice creams. Kappa carrageenan also helps retain water in meats (ham), fish, and cooked products.

Other uses: as an adhesive in bookbinding, in the manufacture of medicine capsules, and in photographic film layers.

ADDITIONAL INFORMATION

There are three types of carrageenan available: kappa, iota, and lambda. The differences are due to the type of algae from which they are extracted and how they are processed. The only difference between the three types of carrageen is the electrical charge of their molecules, which gives them different properties.

Kappa and Iota carrageenan are used as gelling agents, and lambda carrageenan is a thickening agent.

CHARACTERISTICS OF THE SELECTED PRODUCT

The product that we chose to evaluate undergoes a very extensive refinement process from the red algae that results in almost no residual taste in the final culinary product. It contains potassium chloride for a better gellification. Unlike other products, the final gel is not opaque.

BASIC FEATURES

Information provided by the manufacturer.

- Mixture of kappa carrageenan and potassium chloride
- Particle size less than 3% gum on a 0.075 mm sieve test (DIN 80, 200 U.S. mesh)
- Loss on drying < 12%

Energy kcal/100g	240
	g/100g
Total Carbohydrate (maximum)	60
Dietary fiber, (minimum)	30
Total Protein, (maximum)	0
Total Fat	0
	mg/100g
Sodium (maximum)	5000

FIGURE 2.9 NUTRITIONAL VALUE OF THE KAPPA CARRAGEENAN USED.

- pH 7–10 as measured in a 0.5% aqueous solution
- Meat gel strength; > 180 g TA.XT2

NUTRITIONAL VALUE

Information provided by the manufacturer.
(European version)

There are no known restrictions on the consumption of kappa carrageenan. It is a vegetarian texturizing agent.

INSTRUCTIONS FOR USE

PREPARING A KAPPA CARRAGEENAN GEL

1. Add the kappa carrageenan to the liquid that is to be gelled, which should be cold or at room temperature.
2. Mix well with a spoon or whisk.
3. Pour the solution into a saucepan and bring to boil, stirring constantly.
4. Remove from the heat immediately after boiling, and remove the top layer of foam.
5. Pour the mixture into desired mold or container and let to cool in the fridge.

ABOUT GEL PREPARATION

WORKING CONCENTRATION

The basic ration for kitchen/culinary purposes is between 0.2% and 1% kappa carrageen added to the liquid that is to be gelled.

Keep in mind that kappa carrageenan gels have firmer textures than gels produced with other gelling agents. For example, when 200 g of water with kappa carrageenan added is placed in a 3 cm mold, the following gels are obtained from the following concentrations of kappa carrageenan (after boiling and resting in the refrigerator):

- Less than 0.5%: very low viscosity gel. Texture: SAUCE/SYRUP
- Between 0.5 to 0.6%: soft gel. Texture: THICK CREAM/CUSTARD
- Between 0.6 and 0.9%: firm gel. Texture: FLAN/JELLO/ASPIC
- More than 1%: hard gel. Texture: FRUIT LEATHER/ASPIC

The hardness of the gel depends on the concentration of the gelling agent used and the composition of the liquid food product. For example, in tests conducted with water as a medium, a concentration of 0.5% produces a liquid, sauce-like texture. If kappa carrageenan is added to a milk medium at the same concentration, a more gelled texture is produced. The same concentration of gelling agent can produce gels with different textures depending on the food product to which it is applied.

Other factors such as evaporation during the hydration process can also affect the final hardness of the gel, especially when working with small amounts of liquid.

There is no minimum amount of liquid required to form a gel with kappa carrageenan. However, kappa carrageenan must be heated for the hydration stage of gel formation. This process requires a minimum of 100 g of liquid, or else the water will evaporate too quickly, altering the concentration of the gelling agent and resulting in an overly hard gel. Also, a very small amount of liquid will cool too quickly and hinder proper gel formation.

WORKING TEMPERATURE

If the kappa carrageenan solution does not reach a minimum temperature of 80°C/176°F for at least 5 minutes, the hydration process will not be complete and the gel will not form properly.

To ensure that the solution reaches the correct temperature for kappa carrageenan to become fully hydrated, the best method is to bring the liquid to the boiling point and then remove it from the heat.

For kappa carrageenan to retain its technological properties (e.g., its gelling capacity) it should not be submitted to a long period of heat application, a large proportion of the water can evaporate, and the hardness of the resulting gel would be affected.

DISPERSION/HYDRATION

Kappa carrageenan can be dispersed into a cold or room temperature medium without the use of a handheld electric mixer, since the mixture does not thicken when kappa carrageenan is added at low temperatures. It is not recommended to add the carrageenan to a high temperature medium because this is the optimal state for carrageenan to hydrate and lumps can be quickly formed that would be difficult to remove.

Poor dispersion can occur when the food itself does not have enough water, hindering the dispersion process. In this case, a handheld electric mixer is required to help complete the proper dispersion and obtain a satisfactory final result.

During the heating process, it is necessary to mix continuously so the carrageenan does not precipitate from the bottom of the container and to prevent it from sticking. If it happened, a proper hydration would be prevented and the result would be an undesirable texture.

Caution: Keep in mind that if using a hot dispersion with kappa carrageenan some of it may start to gel before all of it the product is hydrated (kappa carrageenan begins to gel at elevated temperatures). If you use an electric beater at this point to remove the clumps this would destroy the gel while it is forming.

Caution: Kappa carrageenan gels begin to gel at high temperatures (around 50°C/122°F), and the gelling process is very quick. Unlike other hydrocolloid gelling agents, kappa carrageenan cannot be used to hydrate only one portion of the product to preserve the organoleptic properties of the product.

Useful Tip: To help prevent clumping, we recommend adding the gelling agent to one part of the dry ingredients in the recipe. For example, if the recipe calls for sugar, add the kappa carrageenan to one part of the sugar and then slowly add the mixture to the liquid. Thus, the dispersion of the kappa carrageenan into the liquid will be improved.

ABOUT THE OBTAINED GEL

The gelling temperature for kappa carrageenan depends on the proportion of the gelling agent used to the amount of liquid that is to be gelled, but it begins at around about 50°C/122°F and is complete at around 35°C/95°F.

The gelling time logically depends on many factors: the concentration of the gelling agent, the amount of liquid to be gelled, the desired texture of the gel to be formed, and the temperature that will be applied to form the gel (refrigerated or room temperature).

Gels may form immediately when working with high concentrations of kappa carrageenan, especially if the liquid is applied to a cold surface or if it comes in contact with a large surface area, enabling it to cool rapidly.

For example, the following gelling times are for a solution of 200 g of water and 1% kappa carrageenan molded in a 3 cm mold (producing a gel with a height of 3 cm):

- In the refrigerator at 4°C/39°F: 20 minutes
- At room temperature to 18°C/64.4°F: 35 minutes

Recommendation: To prevent cross-contamination and microbial growth, it is best to cool the solution in the refrigerator.

Caution: Leave the solution uncovered while it is hot and the gel is forming. Otherwise, condensation of the evaporated water can form a film on top of the solution, which may cause defects in the final result.

Kappa carrageenan gels are reversible, which allows emergency corrections. This practice is not recommended, however, because these gels require high temperatures to melt, and part of the water will be lost in evaporation when heating again to remake the gel, resulting a harder final gel.

BEHAVIOR OF KAPPA CARRAGEENAN WITH VARIOUS FOODS

Keeping in mind that gel formation depends on characteristics of the food product and the concentration of kappa carrageenan used, some parameters are provided by the following observations. For example:

- An excessive amount of salt in the solution to be gelled prevents the gel from forming. For example, kappa carrageenan did not gel when the solution was made of 50% water and 50% soy sauce. The water is attached to the salt, and the gelling agent was not able to integrate properly in the solution.
- Solutions containing alcohol may have difficulty gelling. Increasing the concentration of the gelling agent or diluting the alcohol content by adding water and/or syrup can help solving this problem.
- Kappa carrageenan cannot form a gel in a solution containing fats, even in a solution of 50% oil and 50% water.
- When working with very acidic ($\text{pH} < 2$) solutions, high concentrations of kappa carrageenan are needed to obtain a gel. A concentration of 1% kappa carrageenan on an acidic media produces a very soft gel.
- If calcium or potassium is added to the liquid that is to be gelled or if the food naturally contains a high concentration of calcium or potassium, gel formation will occur more rapidly.

After studying the behavior of kappa carrageenan with various foods, we have concluded that kappa carrageenan will form gels with almost all types of food products (see Annex 1).

Impurities or opacities in a kappa carrageenan gel may be due to the following:

- Foam or bubbles that are formed when the solution is brought to boil which are after not properly removed before the solution is cooled. As kappa carrageenan forms quickly, any foam that forms during the boiling stage must be removed immediately.
- Kappa carrageenan gels can be translucent, depending on the proportion of the gelling agent used and the solution that is to be gelled. For example, a gel made from a water solution with a kappa carrageenan concentration greater than 1% will be completely opaque.

HANDLING AND MANIPULATION OF KAPPA CARRAGEENAN GELS

SERVICE

The range of serving temperatures depends on the concentration of kappa carrageenan used as well as the size of gel that is to be plated, but generally kappa carrageenan gels can withstand temperatures of up to about 60°C/140°F without changing texture characteristics.

STORAGE

The preservation of a kappa carrageenan gel depends on the shelf life of the food with which it is prepared. Pay special attention to the problem of syneresis, which can be an issue with these gels. This residual water can be a source of microbial contamination if proper storage and manipulation practices are not followed correctly.

Kappa carrageenan gels should be stored in the refrigerator, covered with a lid or food-safe plastic wrap to avoid the absorption of other flavors, drying of the gel surface, and avoiding cross-contamination with other foods.

Kappa carrageenan gels cannot be frozen and thawed. Water crystals will form during freezing process that can break the gel structure once thawed.

SYNERGISTIC EFFECTS WITH OTHER GELLING AGENTS

Locust bean gum, xanthan gum, or iota carrageenan (among others) may be used with kappa carrageenan to improve the elasticity of kappa carrageenan gels and to prevent water loss during gel formation (by reducing the amount of syneresis that occurs). Usage amounts depend on which gel properties are most important for the final product: elasticity, heat resistance, or decreased syneresis.

EL RAOR

(FRIED RAOR WITH TEXTURES OF BREAD WITH
TOMATOES AND CONCENTRATED ONION WATER)

JORDI CRUZ, RESTAURANT ABAC (BARCELONA)

SERVES 4 PEOPLE

FISH

Ingredients

4 good-sized Raor fish

Mild olive oil

Salt

Preparation

Fillet the fish, paying careful attention on the scales.

Heat a skillet and add a splash of oil. Once it is hot, fry the fish very quickly, just searing the skin. The scales of the fish will swell and yield a very crisp texture. In the seconds that it takes to fry the skin, the meat will almost be cooked.

Salt the fish lightly and serve immediately.

KAPPA TOMATO MACARONI**Ingredients**

1 kg of ripe tomatoes

1.5 g kappa carrageenan per 100 ml of tomato water

Salt

Arbequina olive oil

Freshly ground black pepper

Preparation

Clean the tomatoes, cut them in quarters, process them in a blender or food processor, and strain them through a sieve to remove the peels and seeds. Place the tomato pulp in a 400 micron cheese-cloth and let the water drain out (reserve water).

Once the tomatoes are completely drained, there will be two products: the tomato water and a dense tomato paste. Season the tomato paste with salt and pepper.

Reduce the tomato water in a wide pan (like one that would be used for a stir-fry) to optimize the flavor. Add the kappa carrageenan and bring the mixture to a boil so that it integrates well. Cool a 4 to 5 mm steel dipstick in a liquid nitrogen bath for 7 seconds and then introduce it into the concentrated tomato water for 2 seconds. A 1 to 2 millimeter tube of concentrated tomato water will form. Cut the tube into pieces, imitating the shape of macaroni. Repeat, until all of the tomato liquid is used. Fill the macaroni with the seasoned tomato pulp and serve with a good arbequina olive oil.

ONION JUICE**Ingredients**

1 kg of onions or red onion Figueras

1 dl mineral water

Butter

Salt and black pepper

Preparation

Peel the onions and place them in a bowl of water.

Roast them at 180°C until they are lightly browned. Season the onions and cover the tray with a plastic wrap.

Reduce the oven temperature to 110°C and cook the onions for 6 to 7 hours.

Reserve the cooking water and strain the onions with cheesecloth to remove all of the remaining water. The obtained onion soup will have intense flavor and will be smooth.

Reduce the juice and give it texture with some butter or even a bit of xanthan gum (at a concentration of 0.1 g per dl).

GARNISHES**Ingredients**

Very thin slices of oven toasted bread

“Petals” of beef and tomato seasoned with salt, pepper, and sugar and baked for a couple of hours at 115°

Coarse breadcrumbs seasoned with tomato, salt, pepper, and Arbequina olive oil

Candied onion peel

Rocket and chive flowers

ASSEMBLY

Heat the tomato confit with some finely chopped chives. Place it in the middle of the plate on top of the freshly fried fish. Place of 4 to 6 pieces of the kappa carrageenan macaroni around the fish. Place the seasoned breadcrumbs, flowers, and toasted bread slices on the plate. Place three shells stuffed with onion and a little of the reduced onion juice. Sprinkle the fish with flaked salt and serve immediately.



(a)



(b)

FIGURE 2.10 EL RAOR.

IOTA CARRAGEENAN

GENERAL INFORMATION

FEATURES AND USE

Iota carrageenan produces gels with soft, malleable textures very similar to those obtained with gelatin. Iota carrageenan gels exhibit some resistance to heat; however, they also are reformable, which means agitation may loosen their structure but the gel structure can reform over time. Iota carrageenan produces such a soft texture that it can even be used to create drinkable gels.

TERMINOLOGY

Iota carrageenan.

ORIGIN

The carrageenan is extracted from red algae (*Rhodophyta*) cell walls (*Gigartina*, *Chondrus*, *Furcellaria*, and *Euchema*) through physical and chemical processes.

NATURAL PROPERTIES

Iota carrageenans are fibrous polysaccharides.

FORMS

Powder, and in a seaweed known as Irish moss (*Chondrus Crispus*).

LEGAL INFORMATION

Iota carrageenan is considered an additive in Europe. The EU Code for carrageenan is E-407.

KEY PROPERTIES

- Iota carrageenan has the properties of a hydrocolloid.
- It is used as a gelling agent, thickener, and stabilizer.
- It disperses in cold water but hydrates in hot water and does not dissolve in oil.
- It forms soft, cohesive (not fragile), elastic gels.
- Iota carrageenan gels are thermoreversible (gelling depends on temperature).
- Iota carrageenan gels are unique in that they are reformable. If the gel is disturbed and destroyed, it can rebuild itself over time. For this reason, iota carrageenan is often used in puddings and other products that need to be transported after they are gelled (as excess motion can break the structure of a gel).

HISTORICAL NOTES

Red algae can be found on the Atlantic coasts of Europe and North America as well as the coasts of the Philippines and Indonesia.

The word *carrageenan* comes from the name of an Irish village where red algae (Irish moss) have been used as food and for medicine purposes since Middle Ages. Industrial production of carrageenan as a gelling agent and thickener began in the twentieth century.

GENERAL APPLICATIONS

For the food industry: dairy products, creams, ice cream, and especially in the preparation of puddings. Chewing gum and candy with cooling/refreshing properties.

Other uses: as an adhesive in bookbinding, in the manufacture of pharmaceutical capsules, and in the manufacture of photographic film layers.

ADDITIONAL INFORMATION

There are three types of carrageenan available: kappa, iota, and lambda. The differences are due to the type of algae from which they are extracted as well as the method from which they are processed. The only difference between the three types is the electrical charge of their molecules, which gives them different properties.

Kappa and iota carrageenan are used as gelling agents, and lambda carrageenan is used as a thickening agent.

CHARACTERISTICS OF THE SELECTED PRODUCT

The product selected is easy to work with because it contains sodium chloride, which improves the gelling process by helping it to have a better dispersion in the liquid.

BASIC FEATURES

Information provided by the manufacturer.

- Mix of iota carrageenan and sodium chloride
- Particle size: At least 80% of particles are less than 100 microns in size (ASTM screen No. 140)
- Drying loss < 14%
- pH: 7–10, measured in a 1% aqueous solution
- Rheology: break strength of a 1% gel of brine: 35–50 g, measured at 10°C/50°F, on a penetrometer.

NUTRITIONAL VALUE

Information provided by the manufacturer.
(European Community version)

No known restrictions on the consumption of iota carrageenan. Iota carrageenan is a vegetarian texturizing agent.

Energy kcal/100g	110
	g/100g
Total Carbohydrate	0
Dietary Fiber	56
Total Protein	0
Total Fat	0
	mg/100g
Sodium	3500
Potassium	12800
Calcium	200
Magnesium	40

FIGURE 2.11 NUTRITIONAL VALUE OF THE IOTA CARRAGEENAN USED.

INSTRUCTIONS FOR USE

PREPARING IOTA CARRAGEENAN GEL

1. Add the iota carrageenan to the liquid, which should be cold or at room temperature.
2. Agitate well with a hand electric blender.
3. Bring mixture to boil, stirring constantly.
4. Remove mixture from heat as soon as it boils. Skim off any foam.
5. Pour the mixture into the desired mold and let it cool in the refrigerator.

ABOUT GEL PREPARATION

WORKING CONCENTRATION

For cooking purposes, the basic concentration range for iota carra-geenan is between 0.2% and 0.7%.

For example, when 200 g of water with iota carrageenan added is placed in a 3 cm mold, the following gels are obtained from the following

concentrations of kappa carrageenan (after boiling and resting in the refrigerator):

- Concentrations lower than 0.6%: produces a thick texture:
SAUCE/CREAM SUSPENSION
- Concentration of 0.6%: gelling starts to appear. Texture: JAM/JELLY
- Concentrations between 0.6% and 1%: produces soft gels.
Texture: FLAN/JELLO

Gel hardness depends on the concentration of the gelling agent used as well as the composition of the liquid food product, which can modify the structure of the final gel. For example, a 0.6% solution of iota carrageenan in water produces a sauce-like texture, while the same concentration of iota carrageenan in milk produces a gelled texture. The same concentration of gelling agent may produce gels with different textures depending on the characteristics of the food to be gelled.

A minimum of 150 g of liquid to be gelled is necessary to work comfortably with iota carrageenan because it thickens immediately when it is dispersed in a cold or room temperature liquid, and agitation with a hand electric blender is required to achieve an adequate dispersion.

WORKING TEMPERATURE

If iota carrageenan solution does not reach a minimum temperature of 80°C/176°F, hydration will be incomplete and the gel will not form properly.

The best method for ensuring that the mixture reaches the correct temperature (and hydration is complete) is to bring the mixture to the boiling point and then remove it from the heat.

Though the iota carrageenan does not lose its gelling ability with heat application, it is best to avoid a prolonged period of time at high temperatures because a large proportion of the water can evaporate, affecting the hardness of the final gel.

We do not recommend adding iota carrageenan to a hot medium for dispersion because higher temperatures are not optimal for hydration and lumps may form, which will be difficult to remove. This could result in incomplete hydration, which would affect the final gel.

DISPERSION/HYDRATION

Iota carrageenan requires strong agitation to achieve a good dispersion into the cold or room temperature medium, as it has a tendency to thicken. Although it may seem hydrated, it will not be fully hydrated without the application of heat.

You cannot mix an iota carrageenan solution with a spoon or whisk. A handheld electric mixer is necessary because iota carrageenan is more difficult to disperse than other hydrocolloids, in part because of the initial viscosity indicated previously.

As already mentioned, heat is required for a complete hydration, but it is also often necessary to stir the mixture to achieve a homogeneous hydration and prevent carrageenan from precipitating and sticking to the bottom of the container.

Heating all of the liquid that is to be gelled is best and will result a better gel. If less than 50% of the mixture is heated, the final hardness of the gel can be compromised significantly.

In exceptional cases, when working with delicate products or foods that can lose their flavor when heated, we recommend heating half of the solution in which the iota carrageenan is dispersed (for hydration) and then adding the other half of the mixture at room temperature to preserve the organoleptic properties of the food.

Useful Tip: To prevent the iota carrageenan from clumping in the solution, add a portion of the iota carrageenan to the dry ingredients used in the recipe. For example, if the recipe calls for sugar, add the gelling agent to a part of the sugar and then slowly pour the mixture into the liquid. Better dispersion is achieved and the formation of lumps is largely avoided.

ABOUT THE OBTAINED GEL

The gelling temperature for iota carrageenan depends on the amount of the gelling agent used and the volume of liquid to be gelled, but it begins to gel at approximately 40°C/104°F and gel formation is complete at about 25°C/77°F.

Gelling time depends on many factors: the concentration of iota carrageenan used, the amount of liquid to be gelled, the shape of the gel, and the temperature at which it is cooled.

For example, the following gelling times are for a solution of 200 g of water and 1% iota carrageenan in a 3 cm. mold (producing a gel with a height of 3 cm):

- In the refrigerator at 4°C/39°F: 45 minutes
- At room temperature (18°C/64.4°F): 1 hour 30 minutes

We observed that if the iota carrageenan gel was left to gel at room temperature, the obtained gel was less firm. We recommend cooling the gel in the refrigerator, which is a safer food handling practice as well.

Caution: Leave the solution uncovered while it is hot and the gel is forming. Otherwise, condensation of the evaporated water can form a film on top of the solution that may cause defects in the final result.

As the iota carrageenan is an elastic gel with reformable characteristics, any vibration or jerky movements that occur during the gelling process can affect the final texture of the gel. Even so, excess movement should be avoided for safety reasons.

BEHAVIOR OF KAPPA CARRAGEENAN WITH VARIOUS FOODS

Gel formation depends on the characteristics of the food to be gelled and the concentration of iota carrageenan used. For example:

- Food products with high calcium content will gel much faster and the resulting gel will be harder.
- An excess of other salts will produce a gel with a softer texture. For example, a solution of 50% water and 50% soy sauce will not form a proper gel.
- Alcoholic beverages usually do not interfere with the gelling process.

- Gel will not form in the presence of oil, even with a solution of 50% oil and 50% water.
- Acid food ($\text{pH} < 2$) requires a higher concentration of iota carrageenan (such as 1%) to gel, and even then the produced gel is soft.

After studying the behavior of the iota carrageenan with different foods, we concluded that iota carrageenan can form a gel with almost all of them (see Annex 1).

If there are impurities or opacities in an iota carrageenan gel, it may be due to the following:

- Air bubbles formed during the mixing process or during boiling that are not correctly removed
- Particles or impurities in the food itself that remain on the surface of the gel during gel formation
- High fat content in the food, which makes the final gel opaque

HANDLING AND MANIPULATION OF IOTA CARRAGEENAN GELS

The temperature that a complete gel can support depends on the amount of gelling agent used and the volume of gel to be heated, but most iota carrageenan gels in any case can withstand temperatures of up to 80°C/176°F before melting.

Iota carrageenan gels are reversible, meaning that they can be melted and recooled to obtain the gel again, but the new gel can have a harder texture if evaporation is not controlled during the second process. The organoleptic characteristics of a reformed gel may also be different because of the prolonged heat exposure.

STORAGE

The shelf life of iota carrageenan gel is linked to the shelf life of the food that was gelled.

Gels should be stored in the refrigerator, covered with a lid to prevent the absorption of other flavors, drying out, and cross-contamination.

We do not recommend freezing iota carrageenan gels because freezing them will affect their structures. However, certain preparations that contain iota carrageenan, such as some foams, can be frozen without any alternations in texture.

Useful Tip: It is best to use a blast chiller instead of a regular freezer because the freezing occurs much more rapidly. Therefore, the frozen water crystals are smaller and less likely to alter the final texture of the final dish, and when thawed are less likely to break the gel texture.

SYNERGISTIC EFFECTS WITH OTHER GELLING AGENTS

Iota and kappa carrageenan can be combined with interesting results, such as improving the resulting gel providing a firmer texture.

MUXARRA WITH MAMIA ROTA

JUAN MARI ARZAK, ARKAZ RESTAURANT (DONOSTI)

SERVES 4

SMOKED CHICKEN BROTH

Ingredients

1 chicken (800 g)

1 c.s. olive oil (0.4°)

2.5 liters water

0.6 g xanthan gum (per 250 g of broth)

2 g smoked lapsang souchong tea (per 250 g of broth)

Salt, chicken bouillon, and pepper

Preparation

Put the chicken, lightly seasoned, in the oven with the oil and roast for 1 hour at 190°C/374°F. Collect all the juice from the roast and reduce it to half. Strain and set aside.

Put the chicken in a saucepan and cover it with water. Cook on low heat for 4 hours. Strain and add texture by introducing the xanthan gum. Infuse mixture with the smoked tea for 4 minutes. Strain, season, and add a pinch of chicken bouillon to the broth.

MAMIA**Ingredients**

200 g sheep milk
10 g sugar
0.7 g iota carrageenan
3 drops of rennet
1 g of salt

Preparation

Blend the milk with the sugar, salt, and iota carrageenan. Boil mixture in a saucepan and then let it cool to 34–36°C/93.2–96.8°F. Add the rennet and let the milk rest in a cool place until it has curdled.

BRINED MUXARRA**Ingredients**

1 muxarra for 400 g
150 g of cooking salt
700 g of smoked lapsang souchong tea
1 dl olive oil
(*) Tea Infusion:
1 L. water, 12 g smoked lapsang souchong tea

Preparation

Boil the water, remove from heat, and add tea. Cover and let it rest for 5 minutes. Strain.

Fillet the fish and cut it into 60 g squares. Make horizontal cuts on the skin that are 1 inch deep. Brine the fish with the salt and the tea for 2 hours. Dry fish well and marinate for 12 hours in the olive oil.

ADDITIONAL INGREDIENTS

Olive oil

Fried pumpkin

Freeze-dried barley leaves

FINAL STEPS AND PRESENTATION

Heat the olive oil to 56°C/132.8°F and cook the muxarra for 7 minutes. Pour the smoked chicken broth over the soup. Place the muxarra on top and the mamia rota to the side. Garnish with the barley leaves.



FIGURE 2.12 MUXARRA WITH BROKEN MAMIA.

HM PECTIN

GENERAL INFORMATION

FEATURES AND USE

HM pectin is widely used in the food industry for the production of jams, marmalades, and jellies. It is widely used in home kitchens for the same purposes and also for making pâtes de fruits. It is very standardized, and there are no remarkable technical issues with its use.

TERMINOLOGY

HM pectin is also known as high methoxyl pectin.

ORIGIN

Pectin is present in the plant cell walls and is obtained from apples or lemon peel or other citrus fruits.

NATURAL PROPERTIES

Pectin is a soluble complex carbohydrate.

FORMS

Powder.

LEGAL INFORMATION

In Europe, pectin is classified as a food additive, with EU code E-440.

KEY PROPERTIES

- HM pectin is a hydrocolloid.
- HM pectin is used as a gelling agent.

- HM pectin disperses in cold water and hydrates in hot liquids and does not dissolve in oil.
- HM pectin requires an acidic medium (pH below 3.6) and a high sugar concentration (45–50° Brix minimum) to form gels. For example, conventional jams must be prepared with 60% sugar to use pectin as a gelling agent.
- Unlike the other major family of pectins (LM pectin), HM pectin produces a thermoirreversible gel that will not melt when subjected to high temperatures.
- HM pectin gels are soft and elastic and also tend to be sticky because of the high sugar concentration.

HISTORICAL NOTES

In 1790, Vauquelin conducted early research on pectin and isolated a gelatinous substance. Pectin was first isolated in 1825 by Braconnot and are shown to be the key in the manufacture of jams and jellies. Braconnot named the substance pectin, drawing from the Greek word *pektos*, meaning strong and firm.

GENERAL APPLICATIONS

Used in the food industry to make jams, preserves, sugar-based confections, and dairy products.

ADDITIONAL INFORMATION

Many types of HM pectin are produced commercially, and most of them contain additional ingredients that enhance gelling properties or are stabilizers.

Some pectins have higher gelling temperatures or shorter gelling times. Because there are so many kinds, it's useful to ask for information from the company or distributor to determine which product will work best for your purposes.

CHARACTERISTICS OF THE SELECTED PRODUCT

The product we selected is the most standard and one of the most widely used in the food industry. It is made from apples and has a rapid gelling time.

BASIC FEATURES

Information provided by the manufacturer.

- Contains high levels of high methoxyl pectin and dextrose
- Granulometry, 1% > 315 microns
- Loss on drying; < 12%
- pH: 2.8–3.5. Measured in a 1% aqueous solution
- Degree of esterification: 66–70%

NUTRITIONAL VALUES

Information provided by the manufacturer.
(European Community version)

Energy kcal/100g	240
	g/100g
Protein	2
Carbohydrate Total	27
Fiber	59
Suger	27
Fat	0
	mg/100g
Calcium	350
Magnesium	40
Sodium	560
Potassium	85

FIGURE 2.13 NUTRITIONAL VALUE OF THE HM PECTIN USED.

There are no known restrictions on the consumption of pectin. Pectin is a vegetable source texturizing agent.

INSTRUCTIONS FOR USE

The usage instructions are designed to accommodate a variety of ingredients, which are typically fruits, as long as the liquid to be gelled fulfills the requirements of a 60% sugar concentration and a minimum degree of acidity.

PREPARATION OF AN HM PECTIN GEL

1. Add the majority of the sugar from the recipe (75%) to the liquid to be gelled, and reserve the rest.
2. Bring mixture to a boil, remove from heat, and then let it cool in the refrigerator.
3. Mix the pectin with the remaining 25% of the sugar and the citric acid.
4. Add the mixture of pectin, sugar, and citric acid to the liquid.
5. Stir with a handheld electric mixer.
6. Bring mixture to a boil for about 5 minutes.
7. Pour mixture into molds and place in the refrigerator to cool.

ABOUT GEL PREPARATION

WORKING CONCENTRATION

In the kitchen, the optimal HM pectin concentrations for gel formation are:

- 1–3% of HM pectin
- 50–65% sugar
- 0.5–1% citric acid

For example, a 2% of HM pectin solution in 200 g of water, with a 50% sugar concentration and 1% citric acid that is brought to a boil, cooled,

and placed into a mold with a depth of 3 cm, produces a gel with the texture of JELLO/JAM. A HM pectin concentration less than 1% produces softer, jelly-like textures.

Gel hardness depends on the concentration of the gelling agent used as well as the composition of the liquid food product, which can modify the final texture of the gel. The same concentration of gelling agent can produce gels with different textures depending on the ingredients to be gelled.

When working with HM pectin to make jams and jellies, evaporation is a very important consideration because it can greatly affect the final texture.

Because of the various steps that must be performed to prepare a pectin solution, is advisable to work with a minimum of 150 g of product to thoroughly mix the pectin with the other ingredients. Besides pectin thickens in a cold medium, the handheld electric hand mixer is necessary to achieve a good dispersion of the pectin into the liquid medium.

WORKING TEMPERATURE

If the HM pectin in solution does not reach a minimum temperature of 80°C/140°F and maintains it for a period of 5 minutes, hydration will not be complete and the gel will not form.

To ensure that you have reached the right temperature and that the HM pectin is fully hydrated, bring the mixture to the boiling point and remove from the heat. Better results are obtained if the mixture is boiled for 5 minutes.

We do not recommend adding the HM pectin to a hot medium for dispersion because higher temperatures are optimal for hydration and lumps will form that will be difficult to remove. This could result in incomplete hydration that could create problems with the final gel.

If using an electric whisk to remove such lumps, take care not to damage the gel while it is forming.

DISPERSION/HYDRATION

HM pectin should be dispersed into cold or room-temperature liquid, with the help of a handheld electric mixer if pectin is added directly to the liquid.

If pectin is added with other dry ingredients such as sugar, simple hand stirring with a spoon is sufficient to achieve a good dispersion. The sugar assists with the dispersion of hydrocolloids (because the two solutes compete to dissolve into the liquid) and prevents clumping, so this is the standard method for adding the pectin to the liquid. The sugar also helps with gel formation.

ABOUT THE OBTAINED GEL

The temperature at which HM pectin begins to gel depends on the sort of pectin applied, the amount of gelling agent used and gel size, but gel formation begins at about 40°C/104°F.

Gelling time also depends on the temperature of the environment in which the mixture is left to cool. Most pectins require longer periods of time for gel formation to complete. The pectin used in this study has a rapid gelling time.

For example, the gelling time required for a 2% HM pectin solution in 200 g of water with a 50% sugar concentration and 1% citric acid placed into a mold with a depth of 3 cm:

- In the refrigerator at 4°C/39°F: 30 minutes
- At room temperature (18°C/64.4°F): 1 hour

Recommendation: For optimal food safety, to avoid cross-contamination and microbiological growth we recommended storing the solution in the refrigerator as it gels.

Caution: Leave the solution uncovered while it is hot and the gel is forming. Otherwise, condensation of the evaporated water can form a film on top of the solution that may cause defects in the final result.

BEHAVIOR OF HM PECTIN WITH VARIOUS FOODS

Gel formation depends on the characteristics of the food product and the concentration of HM pectin used. Our tests found that without a high concentration of sugar and an acid medium, high concentrations of HM pectin will only thicken the solution but will not form a gel. For example:

- Excess salts in the solution that is to be gelled will prevent gel formation, but because of the high sugar content required an extremely salty solution would be unlikely. For example, HM pectin will not form a gel in a solution of 50% water and 50% soy sauce.
- Alcoholic beverages usually gel with the use of high concentrations of HM pectin.
- When added to acidic media ($\text{pH} < 2$), HM pectin forms gels. An acidic medium is necessary for optimum gel formation, as noted earlier.

After studying the behavior of HM pectin with different foods, we conclude that it is possible to obtain gels with foods that have a high sugar concentration and an acid medium (see Annex 1).

If there are impurities or opacities in an HM pectin gel, they may be due to the following:

- Air bubbles formed during the mixing process or during the boiling that are not correctly removed
- Particles or impurities in the food itself

HANDLING AND MANIPULATION OF HM PECTIN GELS

SERVICE

HM pectin produces a thermoirreversible gel that can be heated in the oven without being destroyed. HM pectin gels cannot be melted and reformed in the case of an undesirable result.

Similarly, HM pectin gels can withstand high temperatures and therefore can be served hot, although the necessary high sugar and an acid medium are more often associated with foods that are served cold.

STORAGE

Pectin gels can be sterilized thanks to their thermoirreversible properties. HM pectin is used in baked cookies and in the jams/jellies applied to pastries.

If not heated, the shelf life of the gel largely depends on the shelf life of the product with which it is made.

HM pectin gels should be stored in the refrigerator, covered with a lid to prevent flavors from being absorbed, to prevent drying, and to avoid any cross-contamination.

HM pectin gels cannot be frozen due to the high proportion of sugar that inhibits the freezing process. On the other hand, when working with certain products (e.g., cakes topped with jelly) that need to be frozen for preservation, HM pectin might be an appropriate gelling agent, especially if the product has a high sugar content.

SYNERGISTIC EFFECTS WITH OTHER GELLING AGENTS

HM pectin does not combine with any other common texturing agents in a way that would improve gel formation or produce a gel with special characteristics.

**MANGO, PISTACHIO, AND WHITE
CHOCOLATE ORANGE CAKE**

JOSEP MARIA RIBÉ, PASTRY CHEF

MAKES 10 ROUND CAKES, 16 CM IN DIAMETER AND 4 CM HEIGHT

ORANGE CAKE BASE**Ingredients**

60 g butter

60 g flour

20 g bread flour
125 g whole eggs
100 g egg yolks
50 g milk
75 g sugar
20 g albumin
0.5 g xanthan gum
180 g water
8 g of orange zest
Diced candied orange

Preparation

Melt the butter and whisk together with the two flours to make a roux. Cool mixture slightly and add the egg yolks (off heat) to the roux, stirring quickly.

Simmer the milk with orange zest and add to the butter/flour mixture, stirring vigorously. Put in the blender, process and then strain.

Hydrate the albumin and xanthan gum in water, with the help of the blender.

Beat the hydrated egg whites until soft peaks form, and add the sugar.

Gently fold the egg whites into the remaining ingredients.

Pour in the cake into 14 cm diameter rings and place the candied orange dice on top of the cake.

Bake in the oven at 155°C/311°F.

Keep frozen until service.

**WHITE CHOCOLATE TRUFFLE FILLING
WITH PISTACHIO AND ORANGE****Ingredients**

450 g water
18 g orange flower water

6.5 g gelatin
450 g raw green pistachio paste
675 g good quality white chocolate (34% cocoa)

Preparation

Heat the water to 85°C/185°F and then add hydrated gelatin and stir until dissolved.
Pour gelatin mixture slowly over the white chocolate and pistachio paste to obtain a good emulsion.
Add the orange flower water. Blend mixture with a blender.
Place mixture in 14 cm diameter FlexiSpan molds (around 150 g in each)
Freeze and unmold. Chill until ready to use.

PISTACHIO CRISP, CHOCOLATE, AND WHITE CHOCOLATE CEREAL WITH WHITE INFLATED GRAJEADOS**Ingredients**

280 g raw green pistachio paste
110 g good quality white chocolate (34% cocoa)
270 g dry cereal with white chocolate shavings

Preparation

Melt white chocolate and mix with pistachio paste and cereals.
Take 65–70g portions of the mixture and spread into thin circles (14 cm in diameter).
Freeze circles and keep frozen until ready to use.

LIGHT MANGO MOUSSE**Ingredients**

1100 g mangos puree (10% sucrose)
44 g gelatin
600 g mangos puree (10% sucrose)
60 g albumin powder
150 g sucrose
200 g dextrose
1200 g of whipping cream, whipped lightly

Preparation

Heat a portion of 1100 g of mango puree and dissolve the previously hydrated gelatin in it.

Mix with the remaining 1100 g of puree and set aside.

Blend 600 g of mango puree with the albumin powder in a blender. In a standing mixer, beat the mango/albumin mixture lightly while slowly adding the sucrose and dextrose until soft peaks form.

Gently fold the mango/gelatin mixture into the mango meringue. Add the lightly whipped cream to ensure a smooth and homogeneous mixture.

MANGO GLAZE**Ingredients**

400 g water
600 g glucose syrup DE40
1600 g sucrose
800 g mangos puree (10% sugar)
64 g gelatin in sheets
600 g cold neutral gelatin

Preparation

Boil the water, sucrose, and glucose syrup to 120°C/248°F.

Add the mango puree and previously hydrated gelatin sheets.

Finish by adding the neutral gelatin.

Cool to a temperature of 25–30°C/77–86°F and blend it to make sure there are no air bubbles.

Glaze the cakes while they are still frozen.

MICROWAVE PISTACHIO CAKE

Ingredients

80 g raw green pistachio paste

125 g egg whites

80 g yolks

80 g sugar

30 g flour

Preparation

Mix all the ingredients and pass them through blender.

Drain and fill a siphon until $\frac{3}{4}$ full.

Inject two cartridges and shake well.

Dispense the result in a plastic cup until it is half-full.

Place the bowl in the microwave with ovenproof paper underneath, and cook on high heat for 1 minute.

Cool cakes in the freezer and unmold with the help of a knife.

Keep frozen until ready to serve.

MANGO AND PISTACHIO JAM

Ingredients

2000 g fresh mangos

150 g sugar

14 g medium rapid set pectin

1250 g sugar

200 g glucose syrup DE40

250 g raw green pistachio paste

200 g ground pistachios

Preparation

Blend the mangos to obtain a smooth texture.

Add 1250 g of sucrose and the ground pistachios. Bring the mixture to a boil.

Let the mixture stand at room temperature for 12 hours.

Heat the mango and sucrose mixture again up to 45°C/113°F. Whisk the remaining 150 g of sucrose with the pectin, and stir into the mango mixture.

Continue to heat the mixture and add the glucose syrup.

Boil to obtain a sugar concentration of 65°Brix.

Mix a small portion of the jam with the pistachio paste until you obtain uniform consistency, then add and mix the rest of the pistachio paste with the rest of the jam.

Store in a cool place until use.

ORANGE MARSHMALLOW**Ingredients**

50 g water

150 g sucrose

50 g inverted sugar

100 g glucose syrup

12 g gelatin

125 g egg whites

14 g orange flower water

8 g orange zest

Preparation

Mix water, sucrose, inverted sugar, and glucose syrup, and boil to 140°C/284°F.

Stir the gelatin (previously hydrated) into the syrup.

Pour mixture slowly over the partially whipped egg whites and continue to beat mixture until it cools to about 50°C/122°F.

Spread mixture over a Silpat coated with a thin layer of starch and powdered sugar. Finish by sprinkling more sugar and starch on top and let it sit in refrigerator until needed.

Before service, pass through a sieve to remove the excess sugar and starch.

ASSEMBLY

Place the cakes upside down inside molds that are 16 cm in diameter and 4 cm in height.

Spread a small amount of mango mousse in the bottom of each mold and top with a frozen white chocolate truffle.

Add another layer of mango mousse and insert the crunchy pistachio disk.

Finally spread another layer of mousse, place the orange cake with a thin layer of mango and pistachio jam on top of it, and use plastic to ensure the proper installation of the cakes.

Freeze cakes.

Unmold the cakes and brush with mango glaze.

Decorate the cake with pistachio and orange marshmallows.

LM PECTIN

GENERAL INFORMATION

FEATURES AND USE

Enables gel formation for jams and preserves and forms jellies that contain less sugar (compared with HM pectin) which allow recipes to highlight the natural flavor of the original ingredient.

TERMINOLOGY

LM pectin is also known as low methoxyl pectin.



FIGURE 2.14 MANGO, PISTACHIO AND WHITE CHOCOLATE ORANGE CAKE.

ORIGIN

Pectin is naturally present in the cell walls of plants. It is obtained from apples or lemon peel or from other citrus fruits after specific chemical treatment.

NATURAL PROPERTIES

LM pectin is a soluble complex carbohydrate.

FORMS

Powder.

LEGAL INFORMATION

In Europe, LM pectin is classified as a food additive, with EU code E-440.

KEY PROPERTIES

- LM pectin is a hydrocolloid.
- LM pectin is used as a gelling agent or stabilizer.
- LM pectin disperses in cold water and hydrates in hot liquids and does not dissolve in oil.
- LM pectin requires a calcium-rich medium to form a gel, but unlike HM pectin LM pectin does not need sugar.
- Produces a thermoreversible gel (gel melts with the application of heat).

HISTORICAL NOTES

In 1790, Vauquelin conducted the first research on pectin and isolated a gelatinous substance. Pectin was first isolated in 1825 by Braconnot and shown to be the key in the manufacture of jams and jellies. Braconnot named the substance pectin, drawing from the Greek word *pektos* meaning strong and firm.

GENERAL APPLICATIONS

In the food industry: jams, preserves, sugar-based confections, and dairy products.

ADDITIONAL INFORMATION

Various LM pectins are commercially available, and most of them contain more than one ingredient to enhance gelling ability or stabilizers. We recommend checking the data sheet provided by the company that produces the product before working with it, which should list specific

instructions. There are two types of LM pectin: amidated low methoxyl pectin (LMA) and conventional LM pectin (LM). We used conventional LM pectin for our tests, as described in this chapter.

CHARACTERISTICS OF THE SELECTED PRODUCT

We selected a standard commercially available pectin for our tests, which was a conventional LM pectin.

BASIC FEATURES

Information provided by the manufacturer.

- Contains low methoxyl pectin and dextrose
- Particle size: at least 99% of particles are less than 315 microns (ASTM No. 45 screen)
- Drying loss: < 12%
- pH of 4.3–5.0 . Measured in a 1% aqueous solution
- Degree of esterification: 27–32%

NUTRITIONAL VALUES

Information provided by the manufacturer.
(European Community version)

There are no known restrictions on the consumption of pectin. Pectin is a vegetable source texturizing agent.

INSTRUCTIONS FOR USE

PREPARATION OF AN LM PECTIN GEL

1. Add the pectin to the liquid to be gelled and mix with a handheld electric mixer.
2. Bring mixture to boil and remove any foam that forms on the surface.
3. Pour the mixture into molds and cool in the refrigerator.

Energy kcal/100g	210
	g/100g
Protein	2
Total Carbohydrate	18
Fiber	63
Sugars	18
Fat	0
	mg/100g
Calcium	90
Iron	2
Sodium	2200
Potassium	95

FIGURE 2.15 NUTRITIONAL VALUE OF THE LM PECTIN USED.

For a better gellification, the addition of a small% of calcium salts in the liquid (calcium gluconolactate) is recommended, so LM pectin performs always better in the presence of calcium.

ABOUT GEL PREPARATION

WORKING CONCENTRATION

For cooking purposes, the optimal LM pectin concentrations for gel formation are as follows (for 200 g of water mixed with LM pectin, boiled, placed in a 3 cm thick mold, and cooled in the refrigerator):

- LM concentration less than 1%. Texture: SAUCE/SYRUP
- At LM concentration of 1%, gel formation begins. Soft texture: CUSTARD/JELLO
- LM concentration of 2%. Texture: JELLO

Gel hardness depends on the concentration of the gelling agent used as well as the composition of the liquid food product, which can modify the final texture of the gel. The same concentration of gelling agent can produce gels with different textures depending on the ingredients used and on the natural calcium content of the foodstuff, so calcium-rich foods produce harder gels.

LM pectin disperses into cold liquid but requires a minimum amount of liquid to gel because a handheld electric mixer is necessary to mix the pectin and avoid the formation of lumps. We recommend using a minimum of 150 g of liquid to gel to achieve good homogenization of the sample.

WORKING TEMPERATURE

If the LM pectin in solution does not reach a minimum temperature of 80°C/176°F, hydration will not be complete and the gel will not be able to form.

The best method to ensure that the mixture reaches the correct temperature (to fully hydrate the LM pectin) is to bring the mixture to the boiling point and then remove it from the heat.

We do not recommend adding the LM pectin to a hot medium for dispersion because higher temperatures are optimal for hydration, and lumps will form that are difficult to remove. This could result in incomplete hydration that could create problems with the final gel.

If using an electric whisk to remove such lumps, take care not to damage the gel while it is forming.

DISPERSION/HYDRATION

LM pectin requires strong agitation to achieve a good dispersion into a cold or room temperature medium because it thickens the medium when it is added. The pectin may seem hydrated at this stage, but heat application is necessary for full hydration.

You cannot mix with a spoon or hand mixer because LM pectin is more difficult to disperse than other hydrocolloids, because of the initial viscosity indicated already.

As already mentioned, heat is necessary for hydration, but vigorous stirring is also important to obtain a homogeneous hydration and to prevent the pectin from precipitating and sticking to the bottom of the container.

For the obtaining of an optimal gel, it's best to heat all of the liquid to be gelled. If less than 50% of the liquid is heated, final gel hardness can vary significantly.

Useful Tip: To prevent clumping of LM pectin when it is added to the liquid, mix a portion of the pectin powder with some of the dry ingredients in the recipe (e.g., sugar). Slowly stir the dry ingredients into the liquid to achieve a better dispersion and avoid the formation of lumps.

ABOUT THE OBTAINED GEL

The temperature at which HM pectin begins to gel depends on the amount of gelling agent used and gel size, but gel formation begins at about 40°C/104°F and finishes at about 10°C/50°F.

The time it takes for LM pectin to form a gel depends on the concentration of gelling agent used, the size of gel to be formed, and the cooling temperature, and on an important issue like the calcium content in the foodstuff, then more calcium will means less time.

For example, the following gelling times are for a 1% solution of LM pectin in 200 g of water placed in a 3 cm mold:

- In the refrigerator at 4°C/39°F: 45 minutes
- At room temperature (18°C/64.4°F): 90 minutes

Recommendation: For optimal food safety, to avoid cross-contamination and microbiological growth we recommended storing the solution in the refrigerator during gel formation.

Caution: When the solution is hot, you should not cover the development during the gelation process. Otherwise, condensation of the

evaporated water can form a film on top of the solution and may cause defects in the final result.

If the gel undergoes sudden movements or vibrations during the gelling process, the gel structure may become damaged causing a disagreeable final result.

BEHAVIOR OF LM PECTIN WITH VARIOUS FOODS

Gel formation depends on the characteristics of the food products to be gelled and the concentration of LM pectin used. For example:

- When working with calcium rich foods, correct gel formation occurs, but too much calcium can become problematic.
- Gel formation is not a problem with alcoholic beverages if the alcohol content is relatively low and the solution is rich in sugars.
- Gel formation will not occur in the presence of fat even in a solution of 50% oil and 50% water.
- Gel formation occurs with acid products ($\text{pH} < 2$) but high pectin concentrations are required.

After studying the behavior of LM pectin with different foods, we conclude that it is possible to obtain gels with most foods but using high concentrations of pectin in many cases (see Annex 1).

If there are impurities or opacities in an LM pectin gel, they may be due to the following:

- Air bubbles forming during the mixing process or during boiling that are not correctly removed
- Particles or impurities in the food itself

HANDLING AND MANIPULATION OF LM PECTIN GELS

SERVICE

The heat resistance of a gel depends on the concentration of the gelling agent, the calcium content in the foodstuff and the size of the gel to be heated, but in general LM pectin gels have melting point around 50°C/122°F.

LM pectin gels are thermoreversible. In a situation of error or anomaly, the gel can be brought to a boil, melted, and the gel can reform as it cools. This practice is not recommended except when absolutely necessary. The reformed gel is usually different from the original due to the evaporation that occurs during heating and weakening of the structural capacity of the gelling agent.

STORAGE

The shelf life of the gel largely depends on the shelf life of the product with which it is made.

LM pectin gels should be stored in the refrigerator, covered with a lid to prevent flavors from being absorbed, to prevent drying, and to avoid any cross-contamination.

LM pectin gels cannot withstand freezing and thawing. Freezing causes water crystals that form inside the gel and can break the gel structure, causing syneresis as the gel thaws, resulting an undesirable appearance.

SYNERGISTIC EFFECTS WITH OTHER GELLING AGENTS

LM pectin does not combine with any other common texturing agents in a way that would improve gel formation or produce a gel with special characteristics.

CHOCOLATE HAZELNUT CREAM

RAMÓN MORATÓ, PASTRY CHEF

Ingredients

160 g water
6 g pectin LM OF400
120 g dextrose
600 g sugar-free concentrated milk
50 g cocoa powder
40 g powdered milk 1% M.G
120 g glucose syrup DE 44
4 g fine salt
600 g Gianduja milk chocolate, with 20% hazelnuts
200 g hazelnut paste
600 g caramelized hazelnut praline 50%
2 vanilla beans

Preparation

Mix the pectin with the dextrose. Heat the water and add the pectin/dextrose mixture, stirring until they are well incorporated.
Bring the mixture to a boil, and add the milk powder, concentrated milk, cocoa, glucose syrup, and salt.
Bring the mixture to a boil again, remove from heat, and infuse mixture with the vanilla pods.
Strain the mixture and pour it over the Gianduja chocolate, hazelnut paste, and hazelnut praline.
Emulsify and pour into prepared molds.
Sterilize and set aside.



FIGURE 2.16 CHOCOLATE HAZELNUT CREAM.

HIGH ACYL (ELASTIC) GELLAN GUM

GENERAL INFORMATION

FEATURES AND USE

Elastic (high acyl) gellan gum produces soft and elastic gels capable of withstanding low heat. Gellan gum is one of the best gelling agents for protecting the organoleptic properties of the food to be gelled.

TERMINOLOGY

High acyl (elastic) gellan gum.

ORIGIN

Gellan gum is produced during fermentation of carbohydrates by *Sphingomonas elodea* bacteria.

NATURAL PROPERTIES

Gellan gum is a soluble carbohydrate.

FORM

Powder.

LEGAL INFORMATION

In Europe, gellan gum is classified as a food additive, with EU code E-418.

KEY PROPERTIES

- Gellan gum is a hydrocolloid.
- Gellan gum is used as a gelling agent or stabilizer.
- Gellan gum disperses in cold water and hydrates in hot liquids and does not dissolve in oil.
- Gellan gum works better and more consistently with foods that contain calcium or have low acidity.
- Gellan gum in low concentrations has been used to achieve a suspension effect in liquid.
- Gellan gum has no affect on the flavor of the final product since it is derived from sugar.

HISTORICAL NOTES

Gellan gum was first discovered in 1977 in the United States and was isolated for the first time in Stone Valley Lake, Pennsylvania.

GENERAL APPLICATIONS

In the food industry: ice cream, sweets, and drinks but is rarely used due to its high cost.

Other uses: shampoos and derivatives.

ADDITIONAL INFORMATION

Depending on the industrial process, two different types of gellan gum can be obtained. One type produces gels that are more rigid (low acyl gellan gum) due its molecular composition, and the other one produces elastic gels (high acyl gellan gum), which is the type considered in this chapter.

CHARACTERISTICS OF THE SELECTED PRODUCT

We chose this product because of its particular use in the kitchen and for its ability to produce elastic gels. It is also used for its suspension effect in beverages.

BASIC FEATURES

Information provided by the manufacturer.

- Particle size: 28 mesh (600 μm) not less than 99% of particles through; 42 mesh (355 μm) not less than 97% of particles through.
- Drying loss: not more than 14%
- pH: 4.5–6.5. Measured in a 0.5% aqueous solution of distilled water
- Gel strength, puncture; force: 400–650 g/cm², distance not less than 80%

NUTRITIONAL VALUES

Information provided by the manufacturer.
(European Community version)

Energy kcal/100g	44
	g/100g
Protein	11
Total Carbohydrate	0
Fiber	78
Fat	0
	mg/100g
Calcium	259
Iron	2
Phosphorous	233
Magnesium	98
Sodium	510
Potassium	1930

FIGURE 2.17 NUTRITIONAL VALUE OF THE HIGH ACYL (ELASTIC) GELLAN GUM USED.

There are no known restrictions on the consumption of gellan gum. Gellan gum is allergen-free.

INSTRUCTIONS FOR USE

PREPARATION OF AN ELASTIC (HIGH ACYL) GELLAN GUM GEL

1. Add the gellan gum to the cold or room temperature liquid to be gelled.
2. Mix well with a handheld electric mixer to achieve dispersion.
3. Bring to a boil, stirring constantly.
4. Remove from heat immediately after boiling and remove any possible foam.
5. Pour the mixture into desired mold or container and let cool in the refrigerator.

ABOUT GEL PREPARATION

WORKING CONCENTRATION

The basic working concentration of elastic (high acyl) gellan gum for kitchen purposes is between 0.2% and 0.8%.

For example, a solution of gellan gum placed in 200 g of water, boiled, placed in a 3 cm mold, and cooled in the refrigerator produces the following textures depending on the following concentrations:

- Concentration less than 0.2%: thickens mixture only. Texture: SAUCE/SUSPENSION
- Concentration 0.2%: gelling occurs. Texture: THICK CREAM/CUSTARD
- Between 0.2% and 0.4%: soft gel. Texture: FLAN
- Between 0.4% and 0.6%: firm gel. Texture: JELLO/ASPIC
- Between 0.6% and 0.8%: hard gel. Texture: JELLO/FRUIT LEATHER

The hardness of the gel depends on the concentration of the gelling agent used and the composition of the liquid food to be gelled, which can modify the final texture of the gel. The same concentration of gelling agent can produce gels with different textures according to the food used.

Elastic (high acyl) gellan gum requires a minimum amount of liquid to gel because it thickens the liquid during the cold dispersion process. An electric handheld mixer is needed to prevent lumps during this stage, so we recommend starting with a minimum of 150 g of liquid to get a good homogenization of the product.

Caution: Gellan gum forms gels very quickly at high concentrations, so special care should be taken when working with high concentrations. In addition, larger volumes of liquid should be used so the temperature doesn't lower so quickly.

WORKING TEMPERATURES

Elastic (high acyl) gellan gum must reach a minimum temperature of 90°C/194°F for a period of 5 minutes for complete hydration. Otherwise, the gel does not form properly and the middle of the gel can remain opaque.

The best way to ensure that the mixture reaches the correct temperature for gel formation is to bring the mixture to a boil. This also assures that the gellan gum will become completely hydrated and therefore produce optimal results.

During the heating process prior to dispersion we observed that gellan gum provides viscosity to the medium, but this does not mean that hydration is complete. Full hydration is not complete until the liquid has come to a boil.

If the gelling agent is added to a hot liquid, dispersion may be incomplete and it may become difficult to remove lumps. In hot liquids, the gellan gum molecule is in its optimum state for hydration and begins to gel quickly, giving a result of an undesirable texture.

DISPERSION/HYDRATION

Elastic (high acyl) gellan gum disperses in cold or room-temperature liquids and requires strong agitation with a handheld electric mixer, as the gelling agent increases the viscosity of the liquid and tends to form lumps. This tendency is more pronounced at higher concentrations.

If the lumps are not removed during the dispersion phase the gel will not form correctly because they will not disappear when the liquid is boiled and complete hydration will not occur.

The mixture should be stirred often during the heating process to prevent the gellan gum from precipitating at the bottom of the container, which would prevent proper hydration and result in a gel with an undesirable texture.

Caution: Care should be taken during the dispersion stage if the elastic (high acyl) gellan gum is added to a hot medium as lumps can form easily. A handheld electric mixer can be used to dissolve the

lumps, but the gel may already be starting to form and the agitation can damage the gel.

Caution: Heating a portion of the liquid for hydration, which can be done with other hydrocolloids (to preserve the organoleptic properties of fresh ingredients), is not recommended when working with gellan gum. Keep this limitation in mind when choosing ingredients.

Useful Tip: To avoid clumping when the gellan gum is added to the solution, mix the gellan gum with one part of the dry ingredients in the recipe (e.g., sugar). Slowly stir the dry ingredients into the liquid to achieve a better dispersion and avoid the formation of lumps.

ABOUT THE OBTAINED GEL

The temperature at which the elastic (high acyl) gellan gum gels depends on the amount of gelling agent used and the desired size of the gel. Gel formation begins at around 40°C/104°F.

The gelling time for elastic (high acyl) gellan gum depends on the concentration of gelling agent used, the size of the gel to be formed, and the cooling temperature.

For example, the following gelling times are for a low concentration (0.2%) of elastic gellan gum in 200 g of water placed in a 3 cm thick mold:

- In the refrigerator at 4°C/39°F: 35 minutes
- At room temperature 18°C/64.4°F: 45 minutes

Recommendation: For optimal food safety, to avoid cross-contamination and microbiological growth we recommended storing the solution in the refrigerator during gel formation.

Caution: When the solution is hot, you should not cover it during the gelation process. Otherwise, condensation of the evaporated water can form a film on top of the solution and may cause defects in the final result.

Because high acyl gellan gum gels are soft and elastic, vibrations or jerky movements during gel formation do not significantly affect the final texture of the gel, but it's best to avoid excess motion to ensure an optimal outcome.

BEHAVIOR OF ELASTIC GELLAN GUM WITH VARIOUS FOODS

The formation of a gel depends on characteristics of the food product to gelled and the concentration of gellan gum used. For example:

- The presence of salts such as calcium chloride or sodium chloride slightly increases gel hardness. But food with a very high salt content may hinder gel formation. For example, gellan gum will not gel a solution of 50% water and 50% soy sauce.
- Alcoholic beverages generally do not present problems with gel formation.
- Gel formation will not occur in the presence of fat, even in a solution of 50% oil and 50% water, as the two phases do not mix and the final gel will have clumps.
- Gel formation does not occur with high acid products ($\text{pH} < 2$), but if the acidity of the solution is sufficiently reduced by dilution or by using sodium citrate (see spherification with sodium alginate) gel formation can be achieved.

After studying the behavior of elastic (high acyl) gellan gum with different foods, we conclude that this gelling agent can form a gel with most ingredients (see Annex 1).

If there are impurities or opacities in an elastic (high acyl) gellan gum gel, they may be due to the following:

- Air bubbles forming during the mixing process or during boiling that were not correctly removed
- Particles or impurities in the food that remain on the surface of the gel during gel formation
- Food that has a high proportion of fat or oil, involving a separation of the two phases, with the water phase on the bottom and the oil phase in the top of the gel, will not work or may imply opacity in the gel

HANDLING AND MANIPULATION OF ELASTIC (HIGH ACYL) GELLAN GUM GELS

SERVICE

The heat resistance of a gel depends on the concentration of the gelling agent used and the size of the gel to be heated, but gellan gum gels generally melt at around 50°C/122°F.

Gellan gum gels are thermoreversible. In a situation of error or anomaly, the gel can be brought to a boil, melted, and the gel will reform as it cools. This practice is not recommended except when absolutely necessary. The reformed gel is usually different from the original, thanks to the evaporation that occurs during heating and the weakening of the structural capacity of the gelling agent.

Caution: If the food that is to be gelled has a high calcium concentration, it will have a higher melting point, up to 100°C/212°F.

STORAGE

The shelf life of the gel largely depends on the shelf life of the product with which it is made.

Elastic gellan gum gels should be stored in the refrigerator, covered with a lid to prevent flavors from being absorbed, to prevent drying, and to avoid any cross-contamination.

Gellan gum gels cannot withstand freezing and thawing. Freezing causes water crystals that form inside the gel and can break the gel structure, involving syneresis as the gel thaws, to result in an undesirable appearance.

SYNERGISTIC EFFECTS WITH OTHER GELLING AGENTS

Elastic (high acyl) gellan gum does not combine with any other common texturing agents in a way that would improve gel formation or produce a gel with special characteristics.

**HOT TEA FOR PEOPLE WHO HAVE
DIFFICULTY SWALLOWING**

ALICIA FOUNDATION

INGREDIENTS

5 g Earl Grey tea
1000 g water
30 g sugar
0.2% high acyl gellan gum

PREPARATION

Mix the tea with the water and let it infuse overnight in the refrigerator.

Strain the tea.

Mix the sugar with the gellan gum to make a 0.2% concentration, and pour the mixture into the tea. Mix well with a handheld blender until well dissolved.

Transfer mixture to a saucepan and bring to a boil.

Pour the tea into the desired service glasses and place them in the refrigerator at least for 30 minutes or until completely cold.

Before serving, heat them in a 60°C/140°F oven.

Serve tea with a straw.

This drinkable solid tea is appropriate for people who have difficulty swallowing and consequently cannot drink liquids. The texture achieved is solid enough to be acceptable for their diets.



FIGURE 2.18 HOT TEA FOR PEOPLE WHO HAVE DIFFICULTY SWALLOWING.

RIGID (LOW ACYL) GELLAN GUM

GENERAL INFORMATION

FEATURES AND USE

This type of gellan gum is known as rigid gellan gum. It produces malleable and elastic gels, contrary to what its name suggests. Although it works differently with different foods, it has a number of properties that make it a very complete gelling agent. It is fast-acting, preserves the flavor and color of the original ingredients, and produces heat-resistant gels.

TERMINOLOGY

Low acyl (rigid) gellan gum.

ORIGIN

Gellan gum is produced during carbohydrate fermentation by *Sphingomonas elodea* bacteria.

NATURAL PROPERTIES

Gellan gum is a soluble carbohydrate.

FORM

Powder.

LEGAL INFORMATION

In Europe, gellan gum is classified as a food additive, with EU code E-418.

KEY PROPERTIES

- Gellan gum is a hydrocolloid.
- Gellan gum is used as a gelling agent or stabilizer.
- Gellan gum disperses in cold water and hydrates in hot liquids and does not dissolve in oil.
- Gellan gum works better and more consistently with foods that contain calcium or have low acidity.
- Rigid gellan gum gels are resistant to high temperatures. If the food contains a high percentage of calcium, the resulting gel is extremely heat resistant and may even be thermoirreversible.

HISTORICAL NOTES

Gellan gum was first discovered in 1977 in the United States and was isolated for the first time in Stone Valley Lake, Pennsylvania.

GENERAL APPLICATIONS

In the food industry: Ice cream, sweets, and drinks but is rarely used due to its high cost.

Other uses: shampoos and derivatives.

ADDITIONAL INFORMATION

Depending on the industrial process, two different types of gellan gum can be obtained. One type produces gels that are more rigid (low acyl gellan gum) due its molecular composition, and the other one produces elastic gels (high acyl gellan gum. This chapter covers rigid (low acyl) gellan gum.

CHARACTERISTICS OF THE SELECTED PRODUCT

We chose this product for its ability to product firm but elastic gels and because it produces very little taste in the resulting gel.

BASIC FEATURES

Information provided by the manufacturer.

- Particle size: 80 mesh (180 μm) not less than 99% of particles through; 100 mesh (150 μm) not less than 97% of particles through.
- Drying loss: not more than 14%
- pH: 4.5–6.5. Measured in a 1% aqueous solution of distilled water

Energy kcal/100g	4
	g/100g
Protein	1
Total Carbohydrate	82
Fiber	82
Sugars	0
Fat	0
	mg/100g
Calcium	252
Phosphorous	115
Iron	4
Magnesium	91
Sodium	478
Potassium	4650

FIGURE 2.19 NUTRITIONAL VALUE OF THE LOW ACYL (RIGID) GELLAN GUM USED.

NUTRITIONAL VALUES

Information provided by the manufacturer.
(European Community version)

There are no known restrictions on the consumption of rigid (low acyl) gellan gum. Rigid gellan gum is allergen-free.

INSTRUCTIONS FOR USE

PREPARATION OF A RIGID (LOW ACYL) GELLAN GUM GEL

1. Add the gellan gum to the cold or room temperature liquid to be gelled.
2. Mix well with a handheld electric mixer to achieve dispersion.
3. Bring to a boil, stirring constantly.

4. Remove from heat immediately after boiling and remove any possible foam.
5. Pour the mixture into desired mold or container and let cool in the refrigerator.

ABOUT GEL PREPARATION

WORKING CONCENTRATION

The basic working concentration of rigid (low acyl) gellan gum for kitchen purposes is between 1.0% and 2.5%. It's possible to use a lower concentration, but this range is the most commonly used.

For example, a solution of rigid (low acyl) gellan gum placed into 200 g of water, boiled, placed in a 3 cm mold, and cooled in the refrigerator produces the following textures depending on the following concentrations:

- Concentration less than 1.0%: produces viscosity only. Texture: SAUCE/SUSPENSION
- Concentration 1.0%: gelling begins. Texture THICK CREAM/CUSTARD
- Between 1.2% and 2.0%: firm gel. Texture: ASPIC
- More than 2%: hard gel. Texture: JELLO/FRUIT LEATHER

The hardness of the gel depends on the concentration of the gelling agent used and the composition of the liquid food to be gelled, which can modify the final texture of the gel. The same concentration of gelling agent can produce gels with different textures according to the food used.

Rigid (low acyl) gellan gum requires a minimum amount of liquid to gel because it instantly thickens the liquid when added to a cold or room temperature liquid for dispersion. An electric handheld mixer is needed to prevent lumps during this stage, so we recommend starting with a minimum of 150 g to get a good homogenization.

Caution: Gellan gum forms gels very quickly at high concentrations, so special care should be taken when working with high concentrations and larger volumes of liquid should be used.

WORKING TEMPERATURE

Rigid (low acyl) gellan gum must reach a minimum temperature of 90°C/194°F for a period of 5 minutes for complete hydration. Otherwise, the gel does not form properly and the middle part can remain opaque.

The best way to ensure that the mixture reaches the correct temperature for gel formation is to bring to a boil. This also assures that the gellan gum will become completely hydrated and therefore produce optimal results.

During the heating process prior to dispersion we observed that gellan gum provides viscosity to the medium, but this does not mean that hydration is complete. Full hydration is not complete until the liquid has come to a boil.

If the gelling agent is added to a hot liquid, dispersion may be incomplete and it may become difficult to remove lumps. In hot liquids, the gellan gum molecule is in its optimum state for hydration and begins to gel quickly, resulting in an undesirable texture. If rigid gellan gum is added to a hot liquid and agitated with a handheld electric mixer to remove lumps, the gel that is already starting to form will break and the final gel will not achieve the expected texture.

DISPERSION/HYDRATION

Rigid (low acyl) gellan gum requires strong agitation for good dispersion in cold or room-temperature liquids, as it immediately thickens the solution when added. The handheld electric mixer is recommended (but not essential) even when working at low concentrations to prevent lumps. If lumps do form and are not removed, correct gel formation will not occur. The lumps will not be eliminated when the liquid is boiled, causing an incomplete hydration and an undesirable final texture.

The mixture should be stirred often during the heating process to prevent the gellan gum from precipitating to the bottom of the container, which would prevent proper hydration and result a gel with an undesirable texture.

Caution: Heating a portion of the liquid for hydration, which can be done with other hydrocolloids (to preserve the organoleptic properties of fresh ingredients), is not recommended when working with rigid (low acyl) gellan gum. Keep this limitation in mind when choosing ingredients.

Useful Tip: To avoid clumping when the gellan gum is added to the solution, mix the gellan gum with one part of the dry ingredients in the recipe (e.g., sugar). Slowly stir the dry ingredients into the liquid to achieve a better dispersion and avoid the formation of lumps.

ABOUT THE OBTAINED GEL

The temperature at which rigid (low acyl) gellan gum gels begin to gel depends on the amount of gelling agent used and the desired size of the gel. Gel formation begins at around 40°C/104°F, and rigid gellan gum is considered a fast-acting gelling agent.

The gelling time for rigid (low acyl) gellan gum depends on the concentration of gelling agent used, the size of gel to be formed, the cooling temperature, and the calcium content in the foodstuff. For example, the following gelling times are for a 2.0% concentration of rigid gellan gum in 200 g of water placed in a 3 cm thick mold:

- In the refrigerator at 4°C/39°F: 25 minutes
- At room temperature 18°C/64.4°F: 35 minutes

Recommendation: For optimal food safety, to avoid cross-contamination and microbiological growth, we recommended storing the solution in the refrigerator during gel formation.

Caution: When the solution is hot, you should not cover the development during the gelation process. Otherwise, condensation of the evaporated water can form a film on top of the solution and may cause defects in the final result.

Although rigid gellan gum gels are elastic, it's best to avoid sudden movements during gel formation. The resulting gels are firm and can be broken with excess agitation.

**BEHAVIOR OF RIGID (LOW ACYL) GELLAN
GUM WITH VARIOUS FOODS**

Gel formation depends on characteristics of the food product to gelled and the concentration of gellan gum used. For example:

- A gelling medium that is fortified with calcium and other salts slightly increases gel hardness. But a food with a very high salt content may hinder gel formation. For example, gellan gum cannot form a gel in a solution of 50% water and 50% soy sauce.
- Alcoholic beverages generally do not present problems with gel formation.
- Rigid gellan gum cannot form gel in oil. With a solution of 50% oil and 50% water, the resulting gel structure is very brittle and the two phases separate over time.
- Gel formation does not occur with high acid products ($\text{pH} < 2$). For example, rigid gellan gum will not form a gel with lemon juice, but if the acidity is reduced through dilution or the addition of sodium citrate (see spherification with sodium alginate) gel formation can be achieved.

If there are impurities or opacities in an elastic (high acyl) gellan gum gel, they may be due to the following:

- Air bubbles forming during the mixing process or during boiling that were not correctly removed.
- Particles or impurities in the food that remain on the surface of the gel during gel formation.
- Food that has a high proportion of fat or oil, involving a separation of the two phases, with the water phase on the bottom and the oil phase in the top of the gel, implying a gel that will be opaque and not optimally formed.

HANDLING AND MANIPULATION OF RIGID (LOW ACYL) GELLAN GUM GELS

SERVICE

The heat resistance of a gel depends on the concentration of the gelling agent used and the size of the gel to be heated, but rigid gellan gum gels generally melt at around 75°C/167°F.

It is not always possible to melt a rigid gellan gum gel. The gel becomes thermoirreversible with high concentrations of calcium and with high concentrations of gelling agent. Otherwise, a thermoreversible gel is produced, which can be brought to a boil and melted and will reform as it cools, which is helpful in a situation of error or anomaly. This practice is not recommended except when absolutely necessary. The reformed gel is usually different from the original, due to the evaporation that occurs during heating and the weakening of the structural capacity of the gelling agent.

STORAGE

The shelf life of the gel largely depends on the shelf life of the product with which it is made.

Elastic gellan gum gels should be stored in the refrigerator and covered with a lid to prevent flavors from being absorbed, to prevent drying, and to avoid any cause cross-contamination.

Rigid gellan gum gels cannot withstand freezing and thawing. The gel structure breaks, involving a large amount of syneresis that can damage the final gel structure.

SYNERGISTIC EFFECTS WITH OTHER GELLING AGENTS

Rigid (low acyl) gellan gum does not combine with any other common texturing agents in a way that would improve gel formation or produce a gel with special characteristics.

BANANA FLAMBÉ

DANI GARCÍA, RESTAURANT DANI GARCÍA (MÁLAGA)
DURING HISTIM IN RESTAURANT CALIMA (MÁLAGA)

BANANA SORBET

Ingredients

55 g invert sugar
180 g water
280 g caster sugar
230 g liquid glucose
10 g powdered milk
400 g ripe bananas
30 g cream (35% fat)
7 g sorbet stabilizer
½ vanilla pod

Preparation

Heat the water, the invert sugar, and the liquid glucose in a small pan to 45°C/113°F. Remove from heat and add the caster sugar, powdered milk, sorbet stabilizer, and vanilla pod. Allow mixture to infuse for 5 hours.

Add the ripe bananas and cream and mix very well with an immersion blender. Place mixture in a sorbet machine and freeze according to machine instructions. Place sorbet in a piping bag and store in the freezer for later use.

BANANA MOLDS

Ingredients

Food-grade silicone mixture
1 liter Component A
15 g Component B

Preparation

Mix the two ingredients together with a spatula and remove the air bubbles out with the help of a vacuum machine. Place in the mixture in a 2 cm high mold. Submerge the baby banana into the silicon and allow silicone mixture to set for 24 hours at room temperature. Once silicone is set, make a cross-shaped incision to remove the banana without breaking the mold.

FILLING THE MOLDS

Fill the silicone molds with the banana sorbet and place in the freezer.

BANANA COLORING

Ingredients

200 g black olive juice

40 g liquid glucose

Preparation

Mix the ingredients together in a pan and boil for 5 minutes. Remove from heat and allow cooling at room temperature.

NITROGELLAN COATING

Ingredients

250 g mineral water

250 g yellow grapefruit

5 g rigid (low acyl) gellan gum

Preparation

Place the cold water and the gellan gum in a saucepan and bring to a boil. Remove from heat and mix in the yellow grapefruit juice with the help of a hand blender. Place the mixture back on the heat and bring to a boil. Remove from heat and allow cooling to 85°C/185°F. Keep mixture at this temperature until ready to use.

NITROGELLAN APPLICATION

Remove banana molds from the freezer. Remove the banana sorbet from the molds and place on a tray lined with greaseproof paper. Use a thin brush to paint the banana coloring onto the banana sorbet to resemble the black stripes on a banana. Use tongs or a slotted spatula to dip the banana sorbet into liquid nitrogen for a couple of seconds and then in and out of the NitroGellan mixture in one smooth movement to coat it with a thin layer. Return sorbet bananas to the freezer.

CHOCOLATE “GRAVEL”**Ingredients**

500 g 70% dark chocolate chips
240 g butter
200 g egg yolk
150 g caster sugar
520 g egg white

Preparation

Use a mixer to beat the egg whites until soft peaks form. Remove them from the bowl and place in the fridge. Melt the dark chocolate and keep the melted chocolate at 45°C/113°F. Cream the

butter and sugar in the mixer. Once the butter and sugar are well mixed, add the melted chocolate (at 45°C/113°F) and the egg yolk. Mix well and then fold in the beaten egg whites. Place mixture in a greased baking pan and bake for 12 minutes at 180°C/356°F. Allow to cool. Crumble the cooled sponge cake in a blender to achieve a crumbled texture. Store the obtained product in the refrigerator.

COFFEE TOFFEE

Ingredients

200 g cream

200 g caster sugar

50 g espresso coffee

Preparation

Gently heat the cream in a saucepan. In a separate pan, heat the sugar until it becomes a dark caramel color. When the caramel is ready, carefully add it to the cream and bring the mixture to a boil. Boil mixture for 5 minutes. Add the coffee to the mixture and boil for another 5 minutes. Remove from heat, allow to cool, and store in the fridge.

PLATING AND PRESENTATION

Place a bit of the coffee toffee in the center of the serving plate.

Sprinkle the chocolate gravel over the toffee and place the banana on top.

When serving the dessert tableside, flambé the banana with Ron Miel (honey rum)



FIGURE 2.20 BANANA FLAMBÉ

METHYLCELLULOSE

GENERAL INFORMATION

FEATURES AND USE

Unlike other hydrocolloid gelling agents, methylcellulose gels when heated and melts when cooled. These unique characteristics offer possibilities in the kitchen that are not possible with other gelling agents. Methylcellulose does not require heat for hydration, allowing the preservation of the organoleptic properties of the food to be gelled.

TERMINOLOGY

Methylcellulose.

ORIGIN

Methylcellulose is extracted from plant cellulose through a chemical process.

NATURAL PROPERTIES

Methylcellulose is a soluble carbohydrate.

FORM

Powder.

LEGAL INFORMATION

In Europe, methylcellulose is classified as a food additive, with EU code E-461.

KEY PROPERTIES

- Methylcellulose is a hydrocolloid.
- Methylcellulose is used as a gelling agent, thickener, foaming agent, or stabilizer.
- Methylcellulose disperses in hot or cold water and hydrates in very cold water (below 4°C/39°F) and does not dissolve in oil.
- Methylcellulose is thermoreversible (gel formation is a function of temperature) but acts different from other gelling agents: it gels at hot temperatures (between 50°C/122°F and 70°C/158°F), and the gel melts as the liquid cools (below 50°C/122°F), depending on the food that is gelled.
- Methylcellulose produces gels with a soft texture.

HISTORICAL NOTES

Cellulose is the most abundant substance in plant cell walls. Cellulose was discovered in 1838, but it was not until the mid-twentieth century that the cellulose derivatives such as methylcellulose began to be used in the food industry.

GENERAL APPLICATIONS

In the food industry: candy, creams, puddings, fillings, cream sauces, pizza toppings, croquettes, etc.

Other uses: in pharmaceuticals products like shampoo, toothpaste, paint additives

ADDITIONAL INFORMATION

Methylcellulose is just one of the texturizing agents derived from cellulose. Two other types—carboxymethyl cellulose and hydroxypropyl cellulose—are also used as thickening and foaming agents or stabilizers in the kitchen.

In addition, there are different methylcellulose products on the market, some of which are gelling agents and others that work better as foaming agents.

CHARACTERISTICS OF THE SELECTED PRODUCT

The product we chose has better gelling capacity than foaming properties. It produces firmer gels than other methylcellulose gelling agents. It also adds thickness to the medium during the hydration phase, so at cold temperatures it can be used as a simple thickening agent.

BASIC FEATURES

Information provided by the manufacturer.

- Methoxyl: 29.0–31.5%
- Viscosity: 2% in water 20°C/68°F, 525-980 cps

NUTRITIONAL VALUES

Information provided by the manufacturer.
(European Community Version)

Energy kcal/100g	0
	g/100g
Water	5
Carbohydrates soluble fiber	93.5
Protein	0
Fat	0
	mg/100g
Chloride	610
Iron	15
Sodium	390

FIGURE 2.21 NUTRITIONAL VALUE OF THE METHYLCELLULOSE USED.

There are no known restrictions on the consumption of methylcellulose. Methylcellulose is allergen-free.

If consumed in excessive amounts, methylcellulose can act as a laxative. Such amounts are not typically used for cooking, as the resulting gel would be too hard and brittle to eat.

INSTRUCTIONS FOR USE

PREPARATION OF A METHYLCELLULOSE GEL

There are three methods for preparing methylcellulose gels. The method chosen depends on the recipe.

Method A: Methylcellulose with Liquid Foods

To prepare a gel based on a liquid alimentary product:

1. Add 1% methylcellulose to the liquid to be gelled.
2. Mix well with a handheld electric mixer.
3. Cool the mixture in the freezer or refrigerator to 4°C/39°F.
4. Transfer mixture to desired molds and heat to 80°C/176°F.
5. Serve hot.

Method B: Methylcellulose Base as Food Glue

To prepare a concentrated base of methylcellulose to be used as glue for solid foods:

1. Make a 3% methylcellulose solution in water.
2. Mix well with a handheld electric mixer.
3. Cool the mixture to 4°C/39°F in the freezer or refrigerator.
4. Add this concentrated methylcellulose base sparingly to solids to glue them together.
5. Store in the refrigerator so that methylcellulose glue will hydrate the food until ready to use.
6. Heat 80°C/176°F in a skillet or in the oven.
7. Serve hot.

Method C: Methylcellulose Powder as Food Glue

To prepare a gel (similar to method B) by adding methylcellulose powder to the solid food and then hydrating the glue powder with water from the food itself (works only with foods that have high water content):

1. Mix 0.6% methylcellulose powder to pieces of food to stick them together.
2. Cool the mixture to 4°C/39°F in the freezer or refrigerator.
3. Store in the refrigerator so that methylcellulose glue will hydrate the food, until ready to use.
4. Heat 80°C/176°F in a skillet or in the oven.
5. Serve hot.

ABOUT GEL PREPARATION**WORKING CONCENTRATION****For Method A: Methylcellulose with Liquid Foods**

The basic concentration range for methylcellulose is 0.7% to 1.5%.

For example, for a solution of methylcellulose in 200 g of water that is heated to a temperature of 50°C/122°F or higher, cooled, and placed in a 3 cm thick mold produces the following textures:

- Concentration less than 1%: produces viscosity.
- Concentration around 1%: gelling begins. Texture: THICK CREAM/CUSTARD
- Concentration 1% and slightly over: very soft gel. Texture: FLAN (when hot)
- Concentration between 1.2% and 2%: soft gels. Texture: JAM/JELLY
- Concentration greater than 2%: soft gel, at higher concentrations the texture is similar to the one obtained with a 2% concentration. Texture: JAM

The hardness of the gel depends on the concentration of the gelling agent used and the composition of the liquid food to be gelled, which can modify the final texture of the gel. The same concentration of gelling agent can produce gels with different textures according to the food used.

Because methylcellulose increases the viscosity of the cold medium to which it is added during the dispersion phase, the use of a handheld electric mixer is recommended to aid dispersion and achieve complete hydration without lumps. Therefore, we recommend starting with at least 150 g of liquid.

For Method B: Methylcellulose Base as Food Glue

3.0% methylcellulose in water is the basic working concentration. The concentrated methylcellulose base is then used to join solid foods. The concentration required to glue different solid foods together depends on the amount of food and the format of the finished dish.

It's possible to work with a lower concentration, but the hardness of gel would decrease and the pieces of food may not adhere.

When working with concentrated methylcellulose base, a minimum of 150 g of water is recommended for an adequate hydration and a handheld electric mixer should be used to prevent lumps.

Method C: Methylcellulose Powder as Food Glue

The basic working concentration of methylcellulose is between 0.6% and 1.5%, although this depends on the percentage of water in the food itself. The food releases water and the methylcellulose absorbs it and becomes hydrated. This method is especially recommended for chopped or shredded foods, as it produces the most optimal results.

The normal ration is around 1% methylcellulose per 150 g of solid food pieces.

Caution: This method is not recommended when working with foods that have little water content.

WORKING TEMPERATURES

For Method A: Methylcellulose with Liquid Foods, for Method B: Methylcellulose Base as Food Glue, and for Method C: Methylcellulose Powder as Food Glue

In all three cases the most important factor is a good hydration. Methylcellulose should be hydrated at a temperature at or below 4°C/39°F. If parts of the medium remain at higher temperatures, the mixture will fail to gel when heat is applied.

When there are no opacities and the liquid to be gelled is translucent, then proper hydration of the methylcellulose has occurred. During dispersion, the methyl tends to create opacity in the liquid, though the liquid may not be translucent to begin with. Hydration is complete when the liquid to be gelled returns to its original appearance.

With solid foods, you should observe stickier than normal texture and a transparent appearance.

Useful Tip: If in doubt about refrigeration temperature or hydration time, freezing the solution with methylcellulose is one strategy for ensuring that the solution drops below 4°C/39°F. Freezing does not affect the subsequent gelling abilities of the methylcellulose.

Another temperature that must be considered is the application of heat for gel formation or for gluing solid foods. The solution must be heated to at least 50°C/122°F. It can be heated to higher temperatures, but in the case of method A (not in B or C) if the gel is exposed to very high temperatures it can break.

Once the gel has formed, if the temperature is lowered the gel will melt or the food pieces will come apart. This behavior depends on the concentration of gelling agent used, the amount of liquid or solid that has gelled, and the characteristics of the foods itself.

DISPERSION/HYDRATION

For Method A: Methylcellulose with Liquid Foods, for Method B: Methylcellulose Base as Food Glue, and for Method C: Methylcellulose Powder as Food Glue

Methylcellulose can be dispersed in cold, hot, or room-temperature liquids. In all cases it is best to use a handheld electric mixer to prevent lumps that could hamper subsequent hydration in methods A and B. Methylcellulose disperses easily into a hot medium (up to 50°C/122°F) without forming lumps, so the handheld electric mixer is not necessary.

The dispersion of methylcellulose into a very cold liquid (4°C/39°F and below) can cause clumping, as this is the temperature range at which hydration occurs.

Useful Tip: When you want to hydrate methylcellulose with pieces of solid food, we recommend it advisable to massaging the methylcellulose (liquid or powder) with the food pieces before placing them in the refrigerator.

Useful Tip: To prevent clumping, add the methylcellulose to a portion of the dry ingredients used in the recipe (such as sugar) and gradually add the dry ingredients to the liquid, which will help prevent the formation of lumps.

ABOUT THE OBTAINED GEL

FOR METHOD A: METHYLCELLULOSE WITH LIQUID FOODS, FOR METHOD B: METHYLCELLULOSE BASE AS FOOD GLUE, AND FOR METHOD C: METHYLCELLULOSE POWDER AS FOOD GLUE

Gelling temperature depends on the concentration of methylcellulose used and the size and shape of the desired gel. However, methylcellulose gels form different from the other gelling agents covered so far in this chapter: the gel forms with the application of heat and melts when it is cooled. Typically gel formation begins at around 50°C/122°F.

Gelling time to gel depends on the temperature, and the method used. Applying very direct heat is not recommended—the gel will form on the outside, but the interior will not have time to gel.

BEHAVIOR OF METHYLCELLULOSE GELS WITH VARIOUS FOODS

Gel formation depends on characteristics of the food product to be gelled and the concentration of methylcellulose used.

With Method A: Methylcellulose with Liquid Foods

- In a medium that is rich in salts such as sodium chloride or calcium, methylcellulose loses some of its gelling ability. An excess of salt does not allow the gel to form properly. For example, methylcellulose cannot form a gel in a solution of 50% water and 50% soy sauce.
- Alcoholic beverages do not gel properly with methylcellulose, though it can be used as a thickener applied with these liquids.
- Methylcellulose has emulsifying properties and can form gels in solutions that contain fatty substances. For example, a solution of 50% oil and 50% water will gel in the oven at 80°C in a time

of 15 minutes. The methylcellulose is hydrated with the aqueous portion and the emulsifying oil is added later, similar to the way mayonnaise is prepared.

In Method A it is observed that methylcellulose gels can be formed with almost all food products studied (see Annex 1).

With Method B: Methylcellulose Base as Food Glue

In this method, the methylcellulose base is prepared with water. Gel formation depends on the concentration of methylcellulose base used to bond the solid foods. If hydration occurs correctly, the methylcellulose base can gel all types of smaller sized solid foods. Large pieces of food do not work as well and the appearance can be disagreeable.

Useful Tip: If desired, to increase the flavor of solid foods that are adhered to one another, replace the water used to form the concentrated base with other liquid foods or the food itself. This will improve the taste of the final dish. For example, a mushroom broth can be used to make the glue for mushrooms.

With Method C: Methylcellulose Powder as Food Glue

This method depends on the water content of the food product and on the size of the solid to be glued together. Smaller sizes are better. It's important that the food pieces have high water content.

For Method A: Methylcellulose with Liquid Foods, and for Method B: Methylcellulose Base as Food Glue

Impurities or opacities in a methylcellulose gel may be due to the following:

- Particles or impurities in the food that remain on the surface of the gel during gel formation
- Poor hydration of the methylcellulose

HANDLING AND MANIPULATION OF METHYLCELLULOSE GELS

FOR METHOD A: METHYLCELLULOSE WITH LIQUID FOODS, FOR METHOD B: METHYLCELLULOSE BASE AS FOOD GLUE, AND FOR METHOD C: METHYLCELLULOSE POWDER AS FOOD GLUE

Methylcellulose gels must be served hot. As soon as the gel cools it loses its texture and liquefies, or pieces that were glued together can detach.

The heat resistance of the gel depends on the concentration of methylcellulose used and the size of the gel, but methylcellulose gels are generally stable between 50°C/122°F and 70°C/158°F.

Useful Tip: We recommend serving your food immediately once it has gelled, as the structure will be lost upon cooling.

Methylcellulose gels are technically thermoreversible, but the initial fresh texture is lost during the heating and cooling process. A second heating phase is undesirable because the resulting gel is less optimal than the first one.

STORAGE

For Method A: Methylcellulose with Liquid Foods, for Method B: Methylcellulose Base as Food Glue, and for Method C: Methylcellulose Powder as Food Glue.

Methylcellulose gels and foods that have been glued with methylcellulose cannot be stored in the refrigerator once gelled because (as already mentioned) the gel loses texture when it cools and syneresis occurs. Of course, the mixture can be stored in the refrigerator before heating and until you are ready to apply heat and serve.

The shelf life of methylcellulose gels largely depend on the shelf life of the product with which they are made. Gels should be covered with a lid to prevent odors or flavors being absorbed and to avoid any cross-contamination.

Methylcellulose gels cannot be frozen and thawed of course, but the base ingredients can be frozen and thawed without losing their properties. The hydrated liquid for both Method A and Method B can be frozen and then thawed before heat is applied to form the gel. In this case, preservation in the freezer also depends on the shelf life of the food to be gelled.

SYNERGISTIC EFFECTS WITH OTHER GELLING AGENTS

A combination of methylcellulose with gelatin is used for the foaming technique. Gelatin helps stabilize the foam that is created by the methylcellulose in a cold state. This function disappears once the foam is heated—the gelatin plays the role of an intermediate technological ingredient.

ASPARAGUS VIOGNIER

JOAN ROCA, OF THE RESTAURANT EL CELLER DE CAN ROCA (GIRONA)

COMPONENTS

- Fresh white asparagus
- Royal asparagus
- Methylcellulose
- Voignier
- Ginger Sauce

INGREDIENTS AND PREPARATION

Royal Asparagus

500 g cooked asparagus

200 g cream

30 g powder clear

2 g xanthan

Asparagus tips

Cut the tips from the asparagus and set aside.

Cook the remaining asparagus on the grill. Once the asparagus are cooked, mix them with 200 g of boiled cream. Process the mixture well and strain through a fine sieve. Incorporate the egg whites and xanthan into the strained mixture and blend. Place the mixture into a siphon with two loads of gas and heat in the Roner at 62°C/143°F.

Cut the previously reserved asparagus tips into thin slices and blanch them. Cut strips of greaseproof paper to fit the inside of a circular mold that is 7 cm in diameter. Place the asparagus tips on the greaseproof papers so that they are overlapping. Place the methyl in a thin sleeve and stretch it over the asparagus. Fit the papers with the asparagus tips inside the circular mold. Place the mold in the oven at 150°C/302°F for 5 minutes so that the methylcellulose solidifies and glues all of the asparagus sheets together.

Methyl Cellulose

150 g mineral water

5 g methyl

Mix the water with methyl. Grind and let stand, covered, at 3°C for 12 hours.

Viognier

200 ml Viognier

1 g xanthan

Blend the Voignier and the cold xanthan, and let mixture sit until all of the air is released, or use a vacuum to remove the air bubbles.

Ginger Sauce

150 g cream

3 g grated fresh ginger

1 g dried ginger

Mix all the ingredients.

Boil mixture and reduce it.

Strain mixture, season with salt, and set aside.

Assembly

Candied ginger

Oak sawdust

Place the ring in the center of a plate and fill the interior with hot foam. Remove the ring and paper. Finish the dish by placing a few drops of Viognier, candied ginger, and the reserved ginger sauce. Cover with glass, place the sawdust in a mechanical pipe (smoke machine), and burn it to introduce smoke into the glass.



FIGURE 2.22 ASPARAGUS VIOGNIER.



CHAPTER 3

Thickening Agents



GENERAL PROPERTIES OF THICKENING AGENTS

WHAT IS A THICK TEXTURE?

Thickeners are hydrocolloids. They are texturizing agents that trap water and increase the viscosity of a liquid food. Unlike gelling agents, which trap water to form a network, thickeners produce textures that are more fluid and are not solid.

In this book, the fluid texture produced by thickening agents is defined as a *thick texture*, with a range degree of thickness. An easy way to understand the definition is the difference between food preparations that are able to retain their shape in the form of gel

versus foods that cannot hold their shape and tend to flow (thickened fluids).

HOW DOES A THICKENER WORK?

Thanks to their hydrocolloid properties, thickening agents have the ability to trap water molecules, altering the texture (fluidity) of a liquid.

This process takes place in two phases:

- *Dispersion*: The thickening agent must be homogeneously mixed into the liquid medium.
- *Hydration*: This phase must happen subsequent to the dispersion so that the molecules of the hydrocolloids can alter the viscosity of the water. Heat application is typically necessary for this to occur, although in some cases simple agitation (without heat) is sufficient.

Furthermore, the performance of thickeners, like all texturizing agents, depends greatly on their molecular structure, the concentration used, the temperature, the pH of the hydration medium, the presence of salts in the medium, and the shear (mechanical work applied when mixing), among other factors.

A wide variety of thickening agents is available, each with different dispersion and hydration properties and different viscosity ranges. Each agent produces a different final texture and can produce a range of viscosity depending on heat resistance.

Figure 3.1 shows the characteristics and methods used for the most common thickening agents that are commonly used to provide texture to foods.

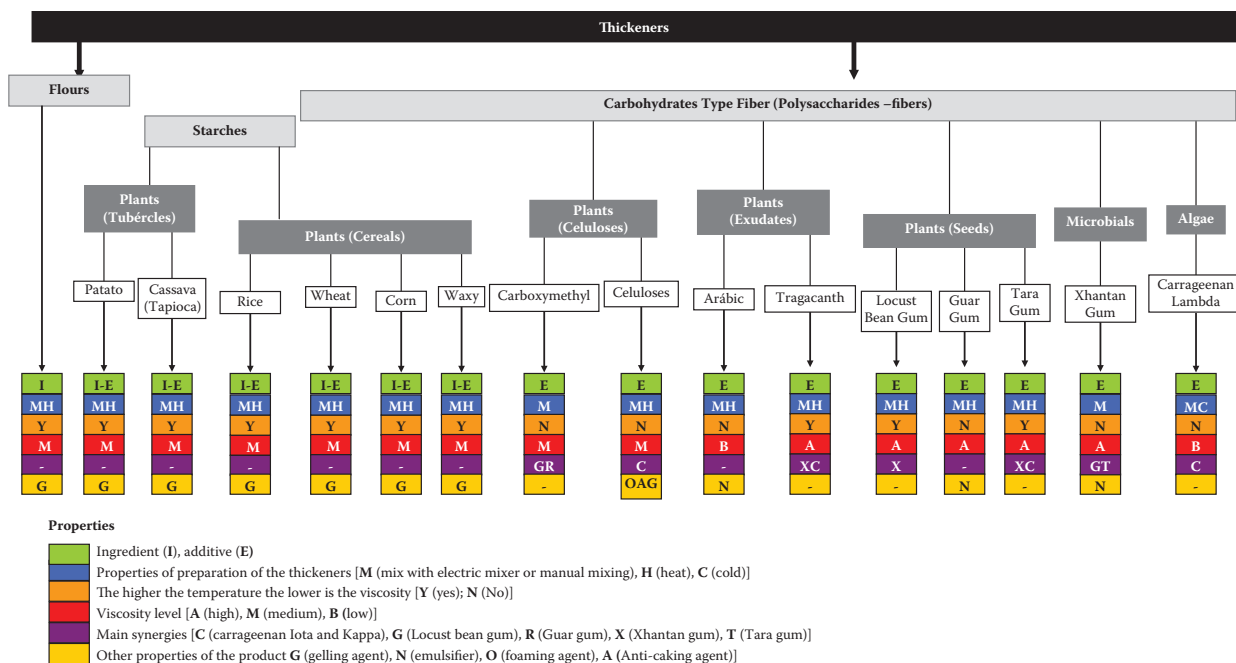


FIGURE 3.1 CHARACTERISTICS OF MAIN THICKENING AGENTS.

THICKENING AGENT TERMS

VISCOSITY

Viscosity is a material's resistance to flow. It is usually associated with liquids, and it can be measured using a viscometer.

Viscosity should not be confused with density. The density of a liquid does not increase when it becomes more viscous. For example, oil is more viscous but less dense than water.

When cooking, viscosity is defined as the thickness of a liquid. We describe sauces or creams as more or less thick, for example. The ability to achieve precise degrees of thickness in the kitchen is very important.

Although it is possible to accurately measure the viscosity of a fluid, there is no universal measuring system. Each company uses its own method and cites different unit values for measuring viscosity in description of its products. Therefore, the viscosity values of different products often cannot be compared, as the measurement process is not standardized.

The grades, in general terms, of thickening agents used for cooking are as follows:

- Low viscosity (vinaigrette)
- Medium viscosity (sauce)
- High viscosity (cream/purée)

The viscosity produced by a thickening agent depends on the type of thickener, the concentration applied, and other parameters such as the type of food used in the preparation.

In general, the concentration of the thickening agent can be increased to achieve a firmer texture. In the same way the concentration can be reduced if a more fluid texture is preferable. The particularities of each case will be detailed throughout the chapter.

ADHESIVENESS OR STICKINESS

The degree of adhesiveness produced by texturizing agents must also be taken into consideration. In this context, the terms *adhesiveness* and *stickiness* refer to the point in which the food adheres to the mouth—the degree of effort required to clear food from the mouth or the time that the liquid remains attached to the inside of the mouth during chewing.

A thick texture may or may not produce adhesiveness, depending on the thickener and the food product used. Adhesiveness is not always associated with the relative thickness of a liquid food.

COMPARING VISCOSITY OF THICKENERS

Figure 3.2 shows the qualitative comparison of the viscosity and thick textures formed with the different thickening agents studied in this book.

High Concentration
Corn strach
Kuzu
Tara Gum
Locust bean gum
Guar gum
Xanthan gum
Low Concentration

FIGURE 3.2 QUALITATIVE COMPARISON OF VISCOSITY

ABOUT THICKENING AGENTS

In this chapter we will describe some of the thickeners that are most commonly used in cooking. The different aspects of each will be discussed to provide a better understanding on how to use them. Please read the entire document because you will find answers to some of the most common questions about the products. The following points are described for each product.

GENERAL DESCRIPTION OF THE THICKENING AGENT

An overview of each thickening agent and its main characteristics is given in this section, including its origin, potential allergens, and the texture and mouthfeel produced, among other important information.

INSTRUCTIONS FOR USE

- Information about how to prepare the thickening agent to obtain a particular viscosity. It includes the following information on how to obtain a thick texture based on the use specifications for each thickener (detailing the necessary steps, concentrations, proper handling, and best practices for achieving optimum results):
 - Guidance on the minimum/maximum amounts of thickening agent required for various types of preparations and expected results.
 - The minimum amount of liquid necessary to achieve good results and avoid any processing problems that could affect final viscosity (e.g., excess evaporation, agitation).
 - Required temperatures for each preparation step, including description on how to apply a very precise temperature when necessary.
 - The amount of mixing needed for good dispersion: strong, medium, or no agitation. This type of agitation determines the type of tool to be used (electric hand mixer versus whisk or spoon) and depends on the thickening properties of the

product, as well as on how much air is incorporated into the medium.

- Some thickening agents can be hydrated into one part of the liquid and later added to the remaining liquid without affecting its properties. This can be a useful technique when the product to be thickened tends to lose its original flavor or aroma during the heating process. This section will explain when this technique is possible and should be considered.
- Information about the characteristics of the obtained texture, whether the preparation can be prepared with any food, and what can be done to improve the outcome when the texture does not meet expectations:
 - Observations about applications with particular liquid foods and concentrations required according to food type.
 - Time required obtaining the desired texture.
 - Limit temperature that the obtained texture can withstand before losing viscosity. This is helpful information when determining service temperature (ideally between 50°C/122°F and 80°C/176°F). This section will take into consideration whether the thickening agent can be liquefied with heat.
- Information on preservation of food products that have been texturized with thickening agents and the appropriate storage conditions:
 - Time during which the thickened texture can be maintained with the same or similar characteristics and description of the ideal conditions for preservation.
 - Whether or not the thickening agent may be frozen and thawed (and maintain the same flavor and texture characteristics).
- Information about potential synergistic effects with other texturizing agents for better results and other possible applications:
- When synergistic effects with other commonly used texturizers can improve the results, such as increasing stability and heat resistance, increasing viscosity, or other effects.

Throughout the usage instructions, we emphasize certain information with the following indications:

Recommendation: special usage advice.

Caution: potential risks associated with process.

Useful Tips: suggestions for methods and procedures.

MAIN CULINARY USES FOR THICKENING AGENTS

Thickening agents create a wide range of viscosities according to the concentration used, producing a variety of different mouth sensations, resulting in a great many different ways to use these texturizers in cooking. [Figure 3.3](#) lists some of the main properties of thickening agents.

The textures presented in the figure are a random sample of different possibilities that can be achieved with a product to provide an idea of the different possibilities to be done. These are not necessarily the only textures that can be produced or the appropriate names for them; these are only examples and can vary depending on many different factors. These examples of how texturizing agents can be used provide a guideline for further experimentation. Of course, the real range of possibilities is much too great to fit into a summary figure.

CORNSTARCH

GENERAL INFORMATION

FEATURES AND USE

Cornstarch is still the most commonly used thickener in Western cuisine. Most professional chefs and pastry chefs are familiar with its uses and properties. The wealth of knowledge available that has to do with

		Textures*												Elaborations**							General Concepts			
		Sauce	Sauce	Nectar	Liquid Cream	Thick Cream	Puree	Texture Flan	Gelée	Nappage	Air	Soft Meringue	Hard Meringue	Marmalade	Aspic	Wrap	Jelly Bean	Mousse	Espuma	Sherbet	Suspension Effect	Technique	Cold Elaboration	Warm Elaboration
Thickening Agents	Corns Tarch	✓✓	✓	✓	✓✓	✓✓	✓	✓	×	✓	×	×	×	×	×	×	×	×	×	✓	×	×	✓	✓✓
	Kudzu Starch	✓✓	✓	✓	✓✓	✓✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	✓	×	×	✓	✓✓
	Xanthan Gum	✓✓	✓	✓✓	✓✓	×	×	×	×	✓	×	×	×	✓	×	×	×	×	×	✓	✓✓	×	✓✓	✓
	Locust Bean Gum	✓✓	✓	✓✓	✓✓	✓✓	✓	×	×	✓	×	×	×	✓	×	×	×	×	×	✓	×	×	✓✓	✓
	Guar Gum	✓✓	✓	✓✓	✓✓	✓✓	✓	×	×	✓	×	×	×	✓	×	×	×	×	×	✓	×	×	✓✓	✓
	Tara Gum	✓✓	×	✓✓	✓✓	✓✓	×	×	×	✓	×	×	×	✓	×	×	×	×	×	✓	×	×	✓✓	✓
		✓✓	It is very appropriate.																					
		✓	It can be used.																					
		×	Not applicable																					

FIGURE 3.3 MAIN PROPERTIES OF THICKENING AGENTS.

its use makes it a very safe product. Even when used in large dosages, cornstarch is technically reliable, with a relatively high margin of error.

TERMINOLOGY

Cornstarch.

ORIGIN

Cornstarch, as its name suggests, is processed from corn.

NATURAL PROPERTIES

Cornstarch is a complex carbohydrate composed of glucose chains arranged in linear (amylose) and branched (amylopectin) form.

FORMS

Powder, with different granulometric sizes (particle sizes).

LEGAL INFORMATION

The cornstarch we studied is a native (unmodified) starch and is classified as an ingredient rather than an additive. Other starches have been modified and are therefore classified as additives and are given E numbers. These starches are modified to enhance certain properties to optimize dispersion or hydration, to enable freeze/thaw cycles without syneresis, or to withstand high cooking temperatures. Modified starches function as thickening agents in mediums that natural unmodified starches cannot or act to generally to increase the stability of the preparation.

KEY PROPERTIES

- Has properties of a hydrocolloid
- Is used as thickener and stabilizing agent

- Disperses in cold water but is hydrated in hot water and does not dissolve in oil
- Requires higher concentrations than other thickening agents
- Final texture varies greatly depending on concentration, in some cases gel formation is possible
- Produces a slightly sticky texture

HISTORICAL NOTES

Thomas Kingsford invented cornstarch in 1840 while he was working in a New Jersey factory that made starch from wheat. He developed a manufacturing process for cornstarch based on a method of manually grinding the corn kernels. Until 1850, cornstarch was not considered edible and was used for industrial purposes and for starching laundry.

GENERAL APPLICATIONS

In the food industry: preparation of cakes and cookies, salad dressings, soups, sauces, for infant and diet foods, and in meat preparations and precooked foods

Other uses: laundry

ADDITIONAL INFORMATION

Cornstarch and flour are the most frequently used thickeners in Western cuisine. Starches can be processed from grains (e.g., wheat, corn, rice) as well as from root plants (e.g., potato, tapioca), but the composition chemical is the same. Because cornstarch requires a high concentration (compared with other thickeners) it inevitably leaves a residual taste and characteristic mouthfeel. This has led to numerous attempts to find alternatives, though over time these characteristics have become accepted.

NATIVE AND MODIFIED STARCHES

Natural or native starches have certain drawbacks, including a tendency to form lumps during dispersion and hydration and ineffectiveness in

acidic media. Modified starches have been developed to circumvent these problems, such as oxidized starch (additive number E1404), acetylated oxidized starch (E 1451), and acetylated starches (E1420, E1422).

CHARACTERISTICS OF THE SELECTED PRODUCT

The product we selected for study is used frequently in cooking. It is a native starch, and its thickening process is easier to standardize.

BASIC FEATURES

Information provided by the manufacturer.

- Water content 12%
- pH: 4.5
- Bulk density (compacted): 700 g/l

NUTRITIONAL VALUE

Information provided by the manufacturer.
(EU version)

Energy kcal/100g	353
	g/100g
Protein	0.3
Carbohydrates (starch)	88
Fat	0.1
	mg/100g
Calcium	5
Sodium	10
Iron	0.2

FIGURE 3.4 NUTRITIONAL VALUE OF CORNSTARCH USED.

Native cornstarch is safe to consume for people with restricted diets, including those with gluten allergies and celiac disease.

INSTRUCTIONS FOR USE

USING CORNSTARCH AS A THICKENER

1. Pour cornstarch on the liquid to be thickened at room temperature. (To add cornstarch to a hot liquid, first disperse the cornstarch in a portion of the liquid that is cold or at room temperature or in a small amount of water. This step will prevent the formation of lumps.)
2. Mix well with wire whisk (depending on the food product).
3. Bring to a boil, stirring constantly.
4. Remove from heat immediately after boiling to prevent excessive evaporation.
5. Cool in the refrigerator (if necessary).

WORKING WITH CORNSTARCH

CONCENTRATION

The basic concentration is a 2% and 10% solution of cornstarch to the total liquid to be thickened. This wide concentration range is because certain food product are already viscous and do not require much cornstarch. Other foods will not develop a viscous texture easily and will require a greater amount of cornstarch.

For example, the following textures are obtained in a 150 g water solution (liquid with a minimum viscosity) at room temperature (18°C/64.4°F) with the following concentrations of cornstarch:

- 2%: mixture begins to thicken. Texture: SAUCE
- 2% to 6%: low viscosity. Texture: SAUCE/CUSTARD
- 6% to 8%: medium viscosity. Texture: HEAVY CREAM/PUREE
- 8% to 10%: high viscosity. Texture: GEL

The same concentration of thickened can produce very different viscosities if water is lost (due to evaporation) during the heating process, which changes the final concentration of thickener to total liquid.

A minimum of 150 g of liquid (to be thickened) is necessary for working comfortably with cornstarch, since such large concentrations of cornstarch are needed for thickening.

Caution: Cornstarch is a very light (non dense) product, so even a seemingly small percentage by weight (less than 5%) can have a large effect on the liquid to be thickened.

TEMPERATURE

If the cornstarch solution does not reach a minimum temperature of 80°C/176°F, hydration will not be complete and the thick texture will not form properly. The end result will be altered, and there will be a discernable raw starch flavor and mealy texture.

The best method for ensuring that the correct temperature is obtained and the cornstarch is fully hydrated is to bring the mixture to the boiling point then immediately remove it from the heat.

Caution: If the liquid is overheated, a higher proportion of water will evaporate, which will change the concentration of cornstarch and alter the final texture.

If a large amount of cornstarch is added to a hot liquid, the product will not disperse sufficiently and will not trap enough water molecules. Uneven thickening will result, including the formation of transparent clumps, causing a lumpy, nonhomogenous texture.

Useful Tip: If the liquid to be thickened is over 50°C/122°F, the cornstarch can first be dispersed in a small amount of the same liquid (or in a small amount of water that will evaporate during the process) that is cold or at room temperature.

DISPERSION/HYDRATION

Cornstarch can be dispersed in the solution using a spoon or a whisk, as it does not require strong agitation if there is sufficient water is available in the liquid (if the liquid to be thickened does not already have a thick

texture). Starch disperses easily into chicken broth, for example, but may require stronger agitation for dispersion into a reduced veal stock.

During the hydration process we recommend stirring constantly to maintain a good dispersion, preventing the starch from precipitating to the bottom of the container (which would alter the desired texture).

It is difficult to hydrate a small part of the liquid with the cornstarch and then add the mixture to the rest of the liquid because the volume of starch is high compared to the volume of liquid. We recommend working with a sufficient amount of liquid to achieve proper hydration.

Useful Tip: When working with volatile products or foods that can lose their organoleptic properties when subjected to heat (e.g., fresh fruit juices or herbal water), a little more than half of the solution can be heated with the cornstarch and the rest can be added later at room temperature. An electric hand mixer is necessary to integrate the two parts while avoiding excessive incorporation of air.

ABOUT THE OBTAINED TEXTURE

The viscosity of liquids thickened with cornstarch increases as the temperature decreases. Depending on the amount of cornstarch in the mixture, the maximum thickness is reached when the product reaches a core temperature of 4°C/39°F. The time it takes to thicken corresponds to the time needed to cool the mixture.

Recommendation: For health reasons, to avoid cross-contamination and microbiological growth, store solution in the refrigerator.

After 24 hours, starch mixtures evolve and thicken and may even turn into a solid gel (like a pudding) if high concentrations are used. Obviously, this texture can be corrected by applying heat or by adding more liquid to the mixture.

Caution: We do not recommend covering the solution as it cools because the condensation of the evaporated water can form a film on top of the solution, which can become an area for microbial growth. However, once the preparation has completely cooled, it should be covered to prevent cross-contamination and unwanted microbiological growth.

Cornstarch produces visibly white or opaque mixtures when cold. The transparency of the mixture increases as the temperature rises. For example, a water solution containing 5% cornstarch:

- Is white and opaque at a temperature less than 25°C/77°F
- Is almost transparent above 40°C/104°F

It is possible to smoothly increase or decrease the thickness of a preparation that been texturized with cornstarch. For a thicker texture, cornstarch can be dispersed into a small amount of liquid and then added to the boiling mixture until desired texture is reached. To thin a preparation, simply add more of the original liquid to obtain desired texture.

CORNSTARCH BEHAVIOR WITH FOOD

The formation of a thick solution depends on the characteristics of the original food product and on the concentration of cornstarch added to the mixture. For example:

- In the presence of excess salt: thickening process is slowed but can occur.
- pH < 2: final viscosity is reduced significantly, but increasing cornstarch concentration can work.
- High proof alcoholic beverages (40°): undesirable and nonhomogenous viscosity.

Cornstarch was capable of producing thickened textures in almost all of the food products that we tested (see Annex 2).

HANDLING AND MANIPULATION OF FOODS THICKENED WITH CORNSTARCH

SERVICE

Textures obtained with cornstarch are very stable and do not usually cause problems during food service. These preparations also tolerate temperature swings and can be reheated several times.

Cornstarch preparations are thicker at cold temperatures and become thinner when the mixture is heated. If the dish is to be served hot, the concentration of cornstarch should be recalculated taking the loss of viscosity with heat into consideration.

Caution: The viscosity of the solution increases each time it is heated due to water evaporation that occurs during the heating process.

STORAGE

As previously mentioned, cornstarch solutions should be stored in the refrigerator to avoid cross-contamination and microbial contamination. The amount of time that the thickened texture can be maintained under these conditions depends primarily on shelf life of the food product.

Caution: Cornstarch mixtures change and thicken after 24 hours, even turning into gels that can be melted. The original texture cannot be restored without adding more liquid.

Caution: Special care should be taken when tasting a cornstarch solution in the kitchen. Salivary enzymes, even in small quantities, can act on the cornstarch carbohydrate chains, thinning the mixture and causing the loss of thickening capability.

Native (unmodified) starches, as in the cornstarch we studied, do not tolerate freezing and thawing. Thawing damages the structure of native starches and causes syneresis. Modified starches can be used in preparations that need to withstand freeze/thaw cycles.

SYNERGISTIC EFFECTS WITH OTHER THICKENING AGENTS

There are no synergistic effects with other commonly used culinary texturizing agents that improve the thickening capacity or other actions of cornstarch.

HOT CHOCOLATE

ENRIC ROVIRA, CHOCOLATIER (BARCELONA)

INGREDIENTS

1000 ml mineral water
25 g cornstarch
220 g dark chocolate (70% cacao), chopped
50 g honey
0.5 g cayenne pepper

PREPARATION

Dissolve the starch in a small portion of the water.
Bring the remaining water to a boil.
Once water boils, remove from heat and add the chopped chocolate, honey, cayenne, and cornstarch (dissolved in water).



FIGURE 3.5 HOT CHOCOLATE.

Mix gently and heat, stirring constantly, until the hot chocolate reaches desired texture.

Let hot chocolate rest for a few minutes before serving.

KUDZU STARCH

GENERAL INFORMATION

FEATURES AND USE

Kudzu starch offers much versatility for create culinary preparations with different textures. This starch can be used in lower concentrations than cornstarch proportions and offers unique organoleptic characteristics.

TERMINOLOGY

Kudzu starch.

ORIGIN

Kudzu starch extracted from the *Pueraria montana* plant, which grows in China and in the southeastern United States. Extraction is a long process that includes separating the starch from the rest of the plant compounds, drying it, and then grinding it into a fine powder.

NATURAL PROPERTIES

Kudzu starch is a complex carbohydrate.

FORMS

Powder, with different granulometric sizes available.

LEGAL INFORMATION

Kudzu starch is a native (unmodified) starch. Classified as an ingredient. No limitation for use and consumption.

KEY PROPERTIES

- Has properties of a hydrocolloid
- Used for its thickening properties
- Disperses in cold water but is hydrated in hot water and does not dissolve in oil
- Higher concentrations are required to achieve thick textures compared with other thickening agents
- Kudzu starch produces thick and gelatinous textures and a prolonged mouthfeel

HISTORICAL NOTES

Kudzu starch was discovered in Kyoto in the twelfth century. The starch was extracting from the inedible fibers of the roots of the kudzu plant. In the seventeenth century, kudzu starch became commercialized and is still used today in traditional Chinese medicine. Kudzu is a thickening agent and a valued ingredient in Asian health remedies.

GENERAL APPLICATIONS

Food industry: sweet confections and candy

Other: preventive medicine, because of its high flavonoid content

ADDITIONAL INFORMATION

Commercially available kudzu starches have a variety of different features and produce different viscosities and can also be combined with other starches. It is important to know whether the starch you are working with is mixed with other starches or not when determining the concentration needed to achieve desired texture.

CHARACTERISTICS OF THE SELECTED PRODUCT

We chose the product based on ease of dispersion.

BASIC FEATURES

Information provided by the manufacturer.

- 100% starch from the root of the *Lobata* variety of the *Pueraria montana* plant

NUTRITIONAL VALUE

Information provided by the manufacturer.
(EU version)

Kudzu starch is safe to consume for people with restricted diets and does not contain any known allergens and is also safe for those with gluten allergies and celiac disease.

INSTRUCTIONS FOR USE

Kudzu starch can be pulverized in a blender and then sifted through a fine mesh sieve to obtain a smaller particle size to improve the dispersion process (depending on granule size).

Energy kcal/100g	342
	g/100g
Protein	0.2
Carbohydrate	83.8
Fiber	0
Fat	0.5

FIGURE 3.6 NUTRITIONAL VALUE OF THE KUDZU STARCH USED.

USING KUDZU STARCH AS A THICKENER

1. Add kudzu starch to the liquid to be thickened at room temperature.
2. Mix well with an electric hand mixer.
3. Bring to a boil, stirring constantly.
4. Remove from heat immediately after mixture comes to the boil.
5. Cool in the refrigerator at 4°C/39°F.

WORKING WITH KUDZU STARCH**CONCENTRATION**

The standard concentration is a 3% to 6% solution of kudzu starch to the liquid to be thickened. For example, the following textures are obtained in a 150 g water solution at room temperature (18°C/64.4°F) with the following concentrations of kudzu starch:

- 3%: begins to thicken. Texture: SAUCE
- 3% to 4%: low viscosity. Texture: SAUCE/CUSTARD
- 4% to 6%: medium viscosity. Texture: HEAVY CREAM
- 6% to 8%: high viscosity. Texture: PUREE

The viscosity of the final product depends on the concentration of the thickener and the composition of the original liquid.

Caution: Kudzu starch is a very light (nondense) product, so even a seemingly small percentage by weight (less than 4%) can look like a large amount compared with other thickening agents.

With regard to the minimum quantity of liquid to be thickened with kudzu starch, there is technically no minimum level, but excessive evaporation must be avoided during the process to prevent undesirable results. We recommend using a minimum of 150 g.

TEMPERATURE

If the kudzu starch solution does not reach a minimum temperature of 80°C/176°F, hydration is not complete and the mixture may not thicken properly.

The best method for ensuring that the correct temperature is obtained and the kudzu starch is fully hydrated (without using a thermometer) is to bring the mixture to the boiling point then immediately remove it from the heat.

Starches require relatively high concentrations to thicken solutions. However, if a large amount of kudzu starch is added to a hot liquid, the starch will not disperse properly and will fail to trap enough water molecules, causing lumps to form that are difficult to remove without the use of an electric beater.

Useful Tip: If the liquid to be thickened is above 50°C/122°F, the kudzu starch should be dispersed in a small portion of the liquid (or in a small amount of water that will evaporate during the process). This method will ensure proper dispersion and optimal conditions for hydration.

DISPERSION/HYDRATION

Kudzu starch can be dispersed into solution with a whisk, as it does not require strong agitation if there is sufficient water available.

Caution: Depending on the initial viscosity of the liquid to be thickened, more agitation may be required. When working with foods that have thicker textures (e.g., creams or reduced stocks), an electric whisk is needed to correctly disperse the kudzu starch.

During the hydration process we recommend stirring constantly to maintain a good dispersion, preventing the starch from precipitating to the bottom of the container (which can produce an undesirable texture).

It is difficult to hydrate a small part of the liquid with the kudzu starch and then add the mixture to the rest of the liquid because the volume of starch is high compared with the volume of liquid. We recommend working with a sufficient amount of liquid to achieve proper hydration.

Useful Tip: When working with volatile products or foods that can lose their organoleptic properties when subjected to heat (e.g., fresh fruit juices or herbal water), a little more than half of the solution can be heated with the cornstarch and the rest can be added later at room

temperature. An electric hand mixer is necessary to integrate the two parts while avoiding excessive incorporation of air.

ABOUT THE OBTAINED TEXTURE

Kudzu starch solutions increase in thickness as they cool down, to about 4°C/39°F (at which point they reach their maximum thickness). Warming these solutions for service can produce a thinner texture than desired. The time it takes to thicken the solution corresponds to the time it takes to cool the mixture.

Recommendation: For health reasons, to avoid cross-contamination and microbiological growth store solution in the refrigerator.

After 24 hours of refrigeration, kudzu starch solutions can thicken and change. High concentration solutions (over 4%) may even turn into a solid gel with a texture similar to flan.

Caution: We do not recommend covering the solution as it cools because the condensation of the evaporated water can form a film on top of the solution, which can become an area for microbial growth. However, once the preparation has completely cooled, it should be covered to prevent cross-contamination and unwanted microbiological growth.

Kudzu starch mixtures resist temperature swings well, so food preparations may be reheated repeatedly during service if necessary.

Caution: The viscosity of the solution increases each time it is heated due to water evaporation that occurs during the heating process. This can be corrected by simply adding water.

It is possible to correct the thickness of a preparation that been texturized with kudzu starch as the concentration can be adjusted without problems. For a thicker texture, kudzu starch can be dispersed into a small amount of liquid and then added to the boiling mixture until desired texture is reached. To thin a preparation, simply add more of the original liquid to obtain desired texture.

Kudzu starch adds some visible opacity to the mixture and cannot be used to produce thickened solutions that are completely clear.

KUDZU STARCH BEHAVIOR WITH DIFFERENT FOODS

The formation of a thick solution depends on the characteristics of the original food product and on the concentration of cornstarch added to the mixture. For example:

- The presence of calcium, salt, sugar, or acid does not affect the final viscosity of the solution.
- High-proof alcoholic beverages (40°) cause the kudzu starch to precipitate, inhibiting formation of thick textures. We recommend lowering the alcohol content before adding the kudzu starch or avoid using kudzu starch with these products.

Kudzu starch was capable of producing thickened textures in the majority of the food products that we tested (see Annex 2).

**HANDLING AND MANIPULATION OF FOODS
THICKENED WITH KUDZU STARCH****SERVICE**

Kudzu starch solutions can be heated, taking into account the aforementioned parameters about the texture when the solution is cooled and the evaporation of water during successive reheating.

Starch solutions are thicker at colder temperatures and become thinner when heated. If the dish is to be served hot, the concentration of cornstarch should be recalculated, taking the loss of viscosity with heat into consideration.

STORAGE

As previously mentioned, kudzu starch solutions should be stored in the refrigerator to avoid cross-contamination and microbial contamination. The amount of time that the thickened texture can be maintained under these conditions depends primarily on shelf life of the food product.

Caution: Special care should be taken when tasting a preparation with kudzu starch in the kitchen. Salivary enzymes, even in small quantities, can act on the cornstarch carbohydrate chains, thinning the mixture.

Kudzu starch preparations do not remain stable with freezing and thawing: a large amount of syneresis occurs and the structure breaks, causing undesirable appearance and texture.

SYNERGISTIC EFFECTS WITH OTHER THICKENING AGENTS

There are no synergistic effects with other commonly used culinary texturizing agents that improve the thickening capacity or other actions of kudzu starch.

POTATOES IN THEIR SAUCE

FINA PUIGDEVALL PERE PLANAGUMÀ, RESTAURANT
LES COLS (OLOT, GIRONA)

INGREDIENTS

400 g red potatoes (red Pontiac) Vall d'en Bas
1 clove of garlic
4 eucalyptus leaves
2 dl sunflower oil
250 ml water
500 ml dark chicken broth
10g sweet red pepper
100g kudzu starch
Maldon salt

PREPARATION

Peel the potatoes and cook them like a stew, with the water, the chicken broth and the sweet red pepper.

Once they are cooked, remove potatoes from the broth (reserve broth) and mix them with a hand blender until a fine potato cream is obtained.

Add salt to taste and set aside.

Reduce and strain the broth.

Heat the potato cream and add the kudzu starch diluted into 1 dl of cold water.

Cool the mixture over a low heat for half an hour until it becomes semitransparent dough.

Place in molds 1.5 cm. high and set aside to cool.

Once cool, cut the potato into portions (simulating potato stew).

Heat in the steam oven at 85°C/185°F for 15 minutes.

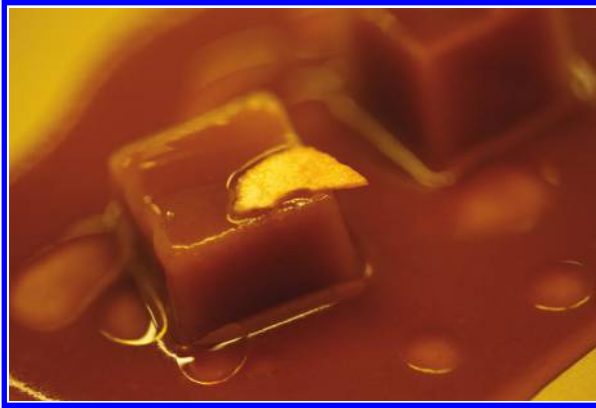
Cool with water and ice.

Peel the garlic clove, cut it into strips, and fry until a crunchy texture is obtained.

Infuse eucalyptus in the oil.

SERVING SUGGESTION

Heat potatoes in the sauce. When ready to serve, add the fried garlic, eucalyptus oil, and Maldon salt.



(a)



(b)

FIGURE 3.7 POTATOES IN THEIR SAUCE.

XANTHAN GUM

GENERAL INFORMATION

FEATURES AND USE

Xanthan gum is a thickener that does not require the application of heat to hydrate in a liquid, protecting the organoleptic properties of the food. Xanthan gum leaves no residual taste and does not alter the

visual appearance of the food preparation. It is one of the new generation hydrocolloids and has rapidly established its place in the kitchen.

TERMINOLOGY

Xanthan gum.

ORIGIN

Xanthan gum is produced from the fermentation of cornstarch with a bacterium *Xanthomonas campestris*, found naturally on cabbages.

NATURAL PROPERTIES

Xanthan gum is a complex carbohydrate.

FORMS

Powder.

LEGAL INFORMATION

Xanthan gum is classified as an additive in Europe. The EU Code for xanthan gum is E-415.

KEY PROPERTIES:

- Has properties of a hydrocolloid.
- Used as a thickener and stabilizer.
- Disperses in cold water but is hydrated in hot water and does not dissolve in oil.
- Because of its rheological properties, xanthan gum can maintain solids in suspension at a certain concentrations. If gas is injected into a liquid thickened with xanthan gum, the liquid will retain more air and the bubbles will not disappear as quickly as they would without the xanthan gum. This does not happen with other thickeners.

- No effect on taste of final product.
- Textures obtained with xanthan gum linger in the mouth, and at concentrations greater than 0.5%, can cause a sticky sensation in the mouth.

HISTORICAL NOTES

Xanthan gum was discovered by the U.S. Department of Agriculture and was first commercially produced by the Kelco Company in the early 1960s. It was approved for use in foods in 1968 and was accepted as a safe food additive in the United States, Canada, Europe, and many other countries.

GENERAL APPLICATIONS

Food industry: emulsions, sauces and ice cream

Other: paint and pigment industry, application of agrochemicals, pet food and inks, among others

ADDITIONAL INFORMATION

When mixed with other polysaccharides, especially locust bean gum and tara gum, xanthan gum can produce a soft gel.

CHARACTERISTICS OF THE SELECTED PRODUCT

The product we chose has properties of taste, appearance, and texture that are very suitable for culinary use. It leaves no aftertaste, is translucent in solution, and can be used in small concentrations.

BASIC FEATURES

Information provided by the manufacturer.

- Particle size: 60 mesh (0.250 mm), % max, and 80 mesh (0.180 mm), % min
- Viscosity (1% in 1% KCl) (25°C) 1400–1700 mPas

Energy kcal/100g	160
	g/100g
Protein	0
Carbohydrate (fiber)	80
	mg/100g
Calcium	30
Magnesium	65
Sodium	3300
Potassium	300

FIGURE 3.8 NUTRITIONAL VALUE OF THE XANTHAN GUM USED.

- pH (1% in water): 6–8
- Moisture: 12%

NUTRITIONAL VALUE

Information provided by the manufacturer.
(EU version)

There are no restrictions on consumption for people with restricted diets and product does not contain any known allergens.

INSTRUCTIONS FOR USE

USING XANTHAN GUM AS A THICKENER

1. Add the xanthan gum to liquid that is to be thickened.
2. Mix well with a handheld electric mixer until no lumps are visible.
3. To remove air bubbles:
 - a. Let the solution stand for at least 3 hours in the refrigerator.
 - b. Use a vacuum to remove the incorporated air.

WORKING WITH XANTHAN GUM

CONCENTRATION

The standard concentration for culinary use is between 0.1% and 0.7% solution of xanthan gum to the liquid to be thickened.

For example, the following textures are obtained in a 150 g water solution at room temperature (18°C/64.4°F) with the following concentrations of xanthan gum:

- 0.1%: mixture begins to thicken. Texture: SUSPENSOR EFFECT
- 0.1% to 0.2%: low viscosity. Texture: SAUCE
- 0.3% to 0.4%: medium viscosity. Texture: THICK SAUCE
- 0.5% to 0.7%: high viscosity. Texture: CUSTARD

Xanthan gum concentrations greater than 1% produce very thick textures with a characteristic appearance (reminiscent of mucus) that is unappetizing.

The viscosity of the final product depends on the concentration of the thickener and the composition of the original liquid, so it is important to take into account the starting texture determining the concentration of xanthan gum to use.

Because xanthan gum requires strong agitation for dispersion and hydration, a handheld electric mixer should be used and a minimum volume of 150 ml of liquid is recommended.

Caution: Successful dispersion of xanthan gum into the liquid depends both on the amount of liquid as well as the length of stirring time: prolonged agitation is necessary for complete incorporation of the xanthan gum into the liquid.

TEMPERATURE

Xanthan gum can be dispersed and hydrated in cold liquids and does not require heat. However, heat does not alter its thickening properties.

On the contrary, if the xanthan gum is added to a hot liquid, less agitation is needed for proper dispersion and hydration. Also less air bubbles will form, simplifying the process because the mixture does not have to rest (to eliminate air bubbles).

Useful Tip: Xanthan gum can be hydrated without agitation; however, the process takes 4 to 7 days, so it is not recommended for culinary purposes.

As already mentioned, air is incorporated into xanthan gum solutions when they are stirred, so we recommend letting the mixture rest for a few minutes after stirring to avoid bubbles in the thickened liquid.

Recommendation: If more agitation is applied to the mixture, more rest time will be needed before use.

Useful Tip: A good option is to use a vacuum packaging machine to remove any air bubbles that form in the solution when using the hand-held electric mixer.

Useful Tip: If you prefer to work fast and to avoid incorporating air into the solution, you can add disperse the xanthan gum to half of the liquid at a cold temperature and then combine it with the other half of the liquid by lightly stirring just enough to produce a homogeneous mixture.

ABOUT THE OBTAINED TEXTURE

The thickening effect of xanthan gum is immediate, irrespective of the temperature of the liquid. Although the viscosity of xanthan gum solutions increases immediately, the final texture of the solution will become apparent only after removing any incorporated air (from stirring) and after a rest period (between 30 and 60 minutes depending on the volume). The change during this time will be minimal, however, so xanthan gum solutions can be used almost immediately if necessary.

The variations in texture that occur when heat is applied to a xanthan gum solution are more related to the changes that may occur with the food itself. The properties of the xanthan gum itself may fluctuate slightly with temperature, but these changes do not affect the final outcome. (For example, if a xanthan gum preparation that is rich in fat is

heated, it will liquefy slightly because the fat is melting, not because the xanthan gum is losing its thickening power.) In culinary uses, xanthan gum produces the same thick textures in both hot and cold temperature environments.

The transparency of xanthan gum solutions decreases with an increase in concentration of xanthan gum. Depending on the food to be thickened, the end result can even be opaque.

To adjust or correct the texture, more xanthan gum can be added to the solution using the same method previously described. The preparation may be diluted with the addition of a small amount of the liquid, which does not contain xanthan gum. Neither of these corrections will alter the optimal organoleptic properties of the final preparation.

XANTHAN GUM BEHAVIOR WITH DIFFERENT FOODS

The formation of a thick solution depends on the characteristics of the original food product and on the concentration of cornstarch added to the mixture. For example:

- Elevated concentration of salts or sugars or acid does not affect hydration.
- Xanthan does not lose its thickening ability in very acidic media ($\text{pH} < 2$).
- Alcoholic beverages do not affect thickening ability, although in solutions with high alcohol content we recommend increasing the concentration of xanthan gum slightly.
- Xanthan gum forms a very stable emulsion in a solution of 50% oil and 50% water, and functions as an emulsifier in those conditions.

Our studies of the behavior of xanthan gum with different food products demonstrated that xanthan gum is capable of producing a thickened preparation in all cases studied (see Annex 2).

HANDLING AND MANIPULATION OF FOODS THICKENED WITH XANTHAN GUM

SERVICE

Xanthan gum solutions can withstand high service temperatures (up to 80°C/176°F) without visible changes in texture.

Although xanthan gum solutions can be reheated several times, the viscosity will increase each time due to water loss from evaporation during the heating process. This can be corrected by simply adding water to the solution or to the liquid that is to be thickened.

STORAGE

The shelf life of a preparation that has been thickened with xanthan gum depends primarily on the shelf life of the food product itself.

Recommendation: For health reasons, to avoid cross-contamination and microbiological growth, it is always advisable to cover the solution and store in the refrigerator.

Freezing and subsequent thawing of xanthan gum preparations did not significantly affect the thickened texture, although the viscosity of the mixture was increased slightly afterward in some of the cases studied.

SYNERGISTIC EFFECTS WITH OTHER THICKENING AGENTS

There are no synergistic effects with other commonly used culinary texturizing agents that improve the thickening capacity of xanthan gum. However, it can be combined with the following:

- Powdered egg whites to stabilize egg white foam (with very low concentrations of xanthan gum)

- Locust bean gum or tara gum to form elastic gels, typically in proportions of 1:1. For example, to make a gel with xanthan gum and locust bean gum, add 0.5% xanthan gum plus 0.5% locust bean gum to the liquid to be gelled and boil the solution.

In addition, xanthan gum can be included in many of formulations involving other hydrocolloids such as sodium alginate and kappa carrageenan.

64% DARK COVERTURE-COFFEE-VANILLA-CINNAMON

RUBÉN ÁLVAREZ, PASTRY CHEF

MAKES FOUR CAKES, 16 CM DIAMETER BY 4 CM TALL

CINNAMON SABLE BRETON

Ingredients

250 g butter
2 g salt
200 g powdered sugar
320 g all-purpose flour
13 g baking powder
85 g almond flour
9 g powdered cinnamon
85 g egg yolks

Preparation

Mix the butter, flour, and baking powder in a standing mixer with the whisk attachment until well mixed.

Add the rest of the ingredients, saving the egg yolks for last.

Roll the dough out between two sheets of parchment paper to 4 mm thickness and then chill in the refrigerator for several hours.

Cut 14 cm diameter discs, place them on a baking sheet lined with parchment, and brush the tops with egg.

Bake at 170–180°C/338–356°F.

COFFEE TOFFEE**Ingredients**

270 g sugar
205 g espresso coffee
240 g egg
6 g gelatin, in leaf form
280 g butter, softened

Preparation

Place the sugar in a dry skillet and heat over medium heat until it caramelizes and turns brown.

Deglaze skillet with the hot espresso coffee.

Pour the hot mixture over the eggs and heat to 82°C/180°F.

Stir in the gelatin.

Cool to 45–50°C/113–122°F and add the softened butter.

Pour 150 g of mixture into each of 4 (14 cm diameter) rings.

Store at –18°C/–0.4°F until ready to use.

VANILLA PANNA COTTA**Ingredients**

600 g cream (35% fat)
150 g whole milk
2 g xanthan gum
75 g sugar
1.5 vanilla beans
11 g gelatin (in leaf form)

Preparation

Use a handheld electric mixer to mix the xanthan gum into the milk.

Split open the vanilla beans and scrape some of their pulp into the cream. Heat the cream, milk, and vanilla beans almost to a boil,

and then remove from heat and set aside a few minutes to infuse the mixture with the vanilla.

Add the sugar and the gelatin sheets and stir until dissolved.

Strain the mixture and then pour 175 g into each of 4 14 cm rings.

Store at $-18^{\circ}\text{C}/-0.4^{\circ}\text{F}$ until ready to use.

64% DARK COVERTURE MOUSSE

Ingredients

300 g milk

200 g cream (35% fat)

50 g inverted sugar

120 g pasteurized egg yolks

8 g leaf gelatin

725 g 64% dark couverture chocolate, chopped

900 g cream, partially whipped

Preparation

Prepare custard with the milk, cream, egg yolks, and inverted sugar.

When custard reaches $82^{\circ}\text{C}/180^{\circ}\text{F}$, add the gelatin and then pour mixture over the chopped chocolate to obtain an emulsion.

When chocolate mixture has cooled to $36^{\circ}\text{C}/97^{\circ}\text{F}$, fold in the softly whipped cream.

GLAZED MILK CHOCOLATE

Ingredients

550 g whole milk

100 g glucose syrup DE40

16 g leaf gelatin

1200 g 38.8% milk chocolate, chopped

200 g cold neutral gelatin

Preparation

Heat the milk with the glucose syrup and dissolve the gelatin sheets. Pour hot mixture over the milk chocolate at intervals, obtaining an emulsion.

Blend and add the neutral gelatin. Let stand.

When ready to use glaze, heat it to about 38°C/100°F.

ASSEMBLY

Divide half the dark couverture mousse among 4 16 cm diameter by 4 cm high baking pans.

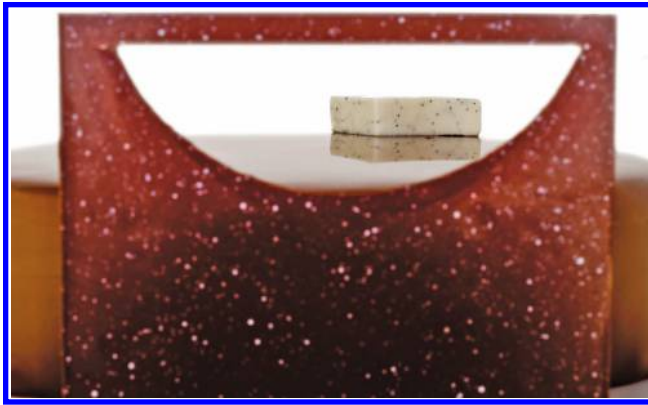
Add the panna cotta filling and then add more of the dark couverture mousse. Add the coffee toffee.

Top with the cinnamon sable breton.

Freeze to -18°C/-0.4°F.

When frozen, invert pan to remove the cake and glaze the frozen cake with the milk chocolate glaze.

Decorate as desired.



(a)



(b)

FIGURE 3.9 64% DARK COBERTURE-COFFEE-VANILLA-CINNAMON.

LOCUST BEAN GUM

GENERAL INFORMATION

FEATURES AND USE

Locust bean gum is a thickening agent that is used in very small amounts in culinary preparations. In addition to its thickening abilities, locust bean gym produces a creamy texture in liquids and can be used to add a pleasing consistency to foods containing little or no fat.

TERMINOLOGY

Locust bean gum is also known as carob bean gum.

ORIGIN

Locust bean gum is extracted from the seeds of the carob tree (*Ceratonia siliqua*), which is found primarily in the coastal areas of the Mediterranean.

NATURAL PROPERTIES

Locust bean gum is a carbohydrate. It is included in the family of galactomannans along with guar gum and tara gum. Galactomannans contain both galactose and mannose units (different types of sugars).

FORMS

Powder.

LEGAL INFORMATION

Locust bean gum is classified as an additive in Europe. The EU Code for locust bean gum is E-410.

KEY PROPERTIES

- Has properties of a hydrocolloid
- Used as a thickener and stabilizer
- Disperses in cold water but is hydrated in hot water, and does not dissolve in oil
- More resistant to acid than other thickening agents in the galactomannan family
- Leaves a residual taste if used in high concentrations
- Produces a smooth texture, and (in medium to high concentrations) can provide a similar texture sensation to that of added fats

HISTORICAL NOTES

Locust bean gum has been used for its thickening properties since ancient times. The Egyptians used locust bean gum paste as adhesive for the bandaging mummies. Industrial production of locust bean gum did not begin until the early twentieth century.

GENERAL APPLICATIONS

Food industry: stabilizer for beverages and soups. Used for making sauces, creams, cookies, specialty breads, jams, and canned vegetables. Whipped cream, ice cream, cheese, etc.

Other: In the pharmaceutical industry, in the cosmetics industry, and in the preparation of pet foods.

ADDITIONAL INFORMATION

Carob flour (often used as a substitute for cocoa powder) is also extracted from the carob tree. The pods and seeds of the carob tree are also edible.

CHARACTERISTICS OF THE SELECTED PRODUCT

The product we chose for our studies has a high degree of refinement and thus has no residual taste and remains transparent in the final food product.

BASIC FEATURES

Information provided by the manufacturer.

- Particle size: maximum 2% > 150 microns
- Humidity: Maximum 14%
- pH: 5.0–7.0. Measured at 1% aqueous solution
- Viscosity: min 2800 mPa.s (Brookfield RVT, spinicle 3, 20 rpm, 1% sol 25°C/77°F)

Energy kcal/100g	30
	g/100g
Protein	5
Dietary fiber	83
Fat	1

FIGURE 3.10 NUTRITIONAL VALUE OF THE LOCUST BEAN GUM USED.

NUTRITIONAL VALUE

Information provided by the manufacturer.
(EU version)

There are no restrictions on consumption for people with restricted diets, and product does not contain allergens.

INSTRUCTIONS FOR USE

USING LOCUST BEAN GUM AS A THICKENER

1. Add the locust bean gum to the liquid that is to be thickened, which should be cold or at room temperature.
2. Mix well with a handheld electric mixer until smooth.
3. Bring to a boil, stirring constantly.
4. Remove from heat and store in the refrigerator.

WORKING WITH LOCUST BEAN GUM

CONCENTRATION

The standard concentration for culinary use is between 0.25% and 1% solution of locust bean gum to the liquid to be thickened.

For example, the following textures are obtained in a 150 g water solution at room temperature (18°C/64.4°F) with the following concentrations of locust bean gum:

- 0.2%: mixture begins to thicken.
- 0.2% to 0.4%: low viscosity. Texture: SAUCE
- 0.5% to 0.7%: medium viscosity. Texture: SAUCE/CUSTARD
- 0.8% to 1%: high viscosity. Texture: THICK CREAM

The viscosity of the final product depends on the concentration of the thickener and the natural composition of the original liquid. The concentration of locust gum needed will depend on the starting viscosity of the liquid to be thickened. (For example, a fish broth will require a different concentration than a béchamel sauce).

The use of a handheld electric mixer is highly recommended because strong agitation is needed to disperse the locust bean gum into solution. Therefore, we recommend working with a minimum of 150 g of liquid to be able to use the mixer effectively.

TEMPERATURE

It is possible to achieve a partial hydration of locust bean gum without heating the solution. However, this method is not recommended because the final product will not be as thick or translucent as one that has been heated. If the locust bean gum in the solution does not reach a minimum temperature of 85–90°C/185–194°F, hydration will not be complete and the solution will not thicken correctly.

The best method for ensuring that the correct temperature is obtained and the locust bean gum is fully hydrated is to bring the mixture to the boiling point then immediately remove it from the heat.

Though locust bean gum does not lose its technological properties (e.g., its thickening capacity) when heated, we do not recommend a prolonged period of heating because a large proportion of water will evaporate and change the final texture of the preparation.

If locust bean gum is added to a hot liquid for hydration, very strong agitation is required to ensure complete dispersion of the thickener into the solution to avoid the creation of lumps that would prevent complete hydration and affect the final result.

DISPERSION/HYDRATION

As already mentioned, bean gum requires strong agitation to ensure a good dispersion, so we strongly recommend using a handheld electric beater rather than a whisk to prevent the formation of lumps that are difficult to remove.

Locust bean gum has the ability to thicken solutions at cold temperatures but may not achieve total hydration, which will lead to the formation of lumps. Pay special attention when adding locust bean gum to a liquid that is cold or at room temperature that the thickener achieves a homogeneous dispersion.

Useful Tip: If the recipe calls for other dry ingredients (e.g. sugar), we recommended mixing the locust bean gum with the dry ingredients before dispersion into the liquid in order to facilitate incorporation and prevent clumping.

When working with ingredients that are sensitive to oxidation or that have volatile aromas such as fresh fruit juices or flavored waters, the locust bean gum can be dispersed in only half of the solution and then added to the other half at room temperature while stirring gently with a wire whisk.

ABOUT THE OBTAINED TEXTURE

A locust bean gum solution will thicken as it cools. The solution will reach its final texture when it is very cold (about 4°C/39°F). The time needed to achieve the thickened texture corresponds to the time needed to cool the mixture.

Caution: We do not recommend covering the solution as it cools because the condensation of the evaporated water can form a film on top of the solution, which can become an area for microbial growth. However, once the preparation has completely cooled, it should be covered to prevent cross-contamination and unwanted microbiological growth.

Once the mixture is cold and the locust bean gum has thickened the solution as much as possible, the mixture can be heated repeatedly without significantly affecting the texture, as only a very minimal variation in texture will occur over time.

When locust bean gum is fully hydrated into a liquid, it is transparent and will not affect the natural appearance of the foods used to prepare the dish.

To adjust or correct the texture, more locust bean gum can be added to the solution using the same method previously described. The preparation may be diluted with the addition of a small amount of the liquid (which does not contain any thickener). Neither of these corrections will alter the optimal organoleptic properties of the final preparation.

LOCUST BEAN GUM BEHAVIOR WITH DIFFERENT FOODS

The formation of a thick solution depends on the characteristics of the original food product and on the concentration of locust bean gum added to the mixture. For example:

- With acidic foods ($\text{pH} < 2$): viscosity is decreased and may not occur at all. For example, when locust bean gum is added to vinegar, the mixture will not thicken correctly. We recommend increase the concentration of locust bean gum when working with acidic liquids.
- With alcoholic beverages: locust bean gum loses thickening properties, especially in liquids with high alcohol content.

Our studies on the behavior of locust bean gum with different food products demonstrated that locust bean gum is capable of producing a thickened preparation in nearly all of the cases studied (see Annex 2).

HANDLING AND MANIPULATION OF FOODS THICKENED WITH LOCUST BEAN GUM

SERVICE

A locust bean gum solution can be heated to $80^{\circ}\text{C}/176^{\circ}\text{F}$, but at higher temperatures locust bean gum begins to lose its properties as a thickening agent and therefore the viscosity of the mixture will be diminished.

As indicated previously, preparations that have been thickened with locust bean gum may be reheated multiple times, though special attention must be paid to the possible evaporation of water, which can cause an undesirable decrease in the viscosity of the dish.

Recommendation: If the dish is to be served hot, do not expect the texture to be the same as when the preparation is cold. The viscosity will be slightly reduced with the application of heat.

STORAGE

The shelf life of a preparation that has been thickened with locust bean gum depends primarily on the shelf life of the food product itself.

Recommendation: For health reasons, to avoid cross-contamination and microbiological growth, it is always advisable to cover the solution and store in the refrigerator.

Locust bean gum solutions can withstand the process of freezing and thawing without losing viscosity. Syneresis is observed after thawing in some cases, but the water is easily reincorporated into a homogenous mixture using simple agitation with a wire whisk.

SYNERGISTIC EFFECTS WITH OTHER THICKENING AGENTS

There are no synergistic effects with other commonly used culinary texturizing agents that improve the thickening capacity of locust bean gum, but locust bean gum can be combined with the following:

- Xanthan gum: to form an elastic gel, as already mentioned in the section on xanthan gum
- Kappa carrageenan: to increase strength and elasticity of the gel and to reduce the syneresis
- Agar-agar: to increase strength and elasticity of the gel

OLIVE OIL GUMMIES

BY CARLOS TEJEDOR, RESTAURANT BY B
(BARCELONA) IN HIS TIME AT VIA VENETO

INGREDIENTS

150 g extra-virgin olive oil
7 g xanthan gum
7 g locust bean gum
320 g glucose
160 g sugar
35 g water

PREPARATION

Combine the olive oil, xanthan gum, and locust bean gum. Blend together with a handheld mixer.

Combine the olive oil mixture with the rest of the ingredients in a saucepan. Bring to a boil, blending with a handheld mixer to create a homogeneous mixture.



FIGURE 3.11 OLIVE OIL GUMMIES.

Working quickly, place the mixture in a pastry bag. Pipe the mixture into molds dusted with cornstarch, pinching the bottom of the pastry bag to release each large drop of the mixture. Try not to touch the gummy mixture with your hands, as it is very sticky. Also, it helps to wear two (or three) layers of gloves, as the mixture is very hot.

Cover the molded candies with more cornstarch. Set aside overnight at room temperature. Remove gummies from molds and brush off excess cornstarch.

Gummies can be stored for up to 5 days at room temperature and 2 weeks in refrigerator.

GUAR GUM

GENERAL INFORMATION

FEATURES AND USE

Guar gum has great excellent thickening capacity even in small doses, which helps prevent any undesirable flavors in the final preparation.

TERMINOLOGY

Also called guaran.

ORIGIN

Guar gum is extracted from the seeds of the leguminous plant *Cyamopsis tetragonolobus*. The guar bean is very similar to the pea. The plant is native to Pakistan and India.

NATURAL PROPERTIES

Guar gum is a carbohydrate. It is included in the family of galactomannans, along with locust bean gum and tara gum. Galactomannans contain both galactose and mannose units (different types of sugars).

FORMS

Powder.

LEGAL INFORMATION

Guar gum is classified as an additive in Europe. The EU Code for guar gum is E-412.

KEY PROPERTIES

- Has properties of a hydrocolloid
- Used as a thickener and stabilizer
- Disperses and hydrates in cold water and does not dissolve in oil
- Leaves a residual taste if used in high concentrations
- Produces very smooth texture and (in medium to high concentrations) can produce a similar mouthfeel to that of added fats

HISTORICAL NOTES

Humans and animals have consumed guar beans for centuries. Guar gum really came into use in the 1940s as a substitute for locust bean gum, which is harvested from trees and is therefore more expensive to produce.

GENERAL APPLICATIONS

Food industry: fresh cheeses, ice cream, sauces, desserts, preserves, jellies and jams

Other: Paper industry (for its humectant properties); in the tobacco industry and the mining industry; also used for water treatment

ADDITIONAL INFORMATION

Guar gum belongs to the galactomannan family, together with locust bean gum and tara gum.

CHARACTERISTICS OF THE SELECTED PRODUCT

The product we selected is highly refined and leaves no residual flavor in the final dish.

BASIC FEATURES

Information provided by the manufacturer.

- 200 grit mesh
- Humidity: Max. 15% (at 105°C for 5 hours)
- Viscosity: 5000 cps minimum

NUTRITIONAL VALUE

Information provided by the manufacturer.
(EU version)

There are no restrictions on consumption for people with restricted diets, and product does not contain allergens.

INSTRUCTIONS FOR USE

USING GUAR GUM AS A THICKENER

1. Add the guar gum to the liquid that is to be thickened, which should be at room temperature.
2. Mix well with a handheld electric mixer.
3. Bring to a boil, stirring constantly, then remove from heat.
4. Let cool completely to complete the hydration process.

	g/100g
Protein	10
Gum content	75

FIGURE 3.12 NUTRITIONAL VALUE OF THE GUAR GUM USED.

Even though guar gum is being considered to create thickness with no need of temperature, the best results are achieved after heating to improve the hydration. Of course, certain viscosity can be achieved by just mixing it in a cold liquid.

WORKING WITH GUAR GUM

CONCENTRATION

The standard concentration for culinary use is between 0.25% and 1% solution of guar gum to the liquid to be thickened.

For example, the following textures are obtained in a 150 g water solution at room temperature (18°C/64.4°F) with the following concentrations of guar gum:

- 0.2%: mixture begins to thicken
- 0.2% to 0.4%: low viscosity. Texture: SAUCE
- 0.5% to 0.7%: medium viscosity. Texture: SAUCE/CUSTARD
- 0.8% to 1%: high viscosity. Texture: THICK CREAM

The viscosity of the final product depends on the concentration of the thickener and the natural composition of the original liquid.

The use of a handheld electric mixer is highly recommended because strong agitation is needed to disperse the guar gum into solution. Therefore, we recommend working with a minimum of 150 g of liquid in order to be able to use the mixer effectively.

TEMPERATURE

If the guar gum solution does not reach a minimum temperature of 85–90°C/185–194°F, hydration will not be as good as expected. Even do it is possible to achieve a partial hydration of guar gum without heating the solution. However, this method is not recommended because the final product will not obtain the maximum thickness that can be obtained only by heating the solution.

Warming the solution to the boiling point and then remove from the heat has been considered the method that ensures the mixture to achieve the correct temperature throughout its volume and that the guar gum is fully hydrated.

Though guar gum does not lose its technological properties (e.g., its thickening capacity) when heated, we do not recommend a prolonged period of heating because a large proportion of water will evaporate and change the final texture of the preparation.

When guar gum is added to a liquid, even if it is hot or cold, very strong agitation is required to ensure complete dispersion and to prevent the formation of lumps. High temperatures are ideal for proper hydration, but a hot dispersion can result in an uneven texture and subsequent partial hydration of the product, causing lumps to form.

DISPERSION/HYDRATION

Guar gum requires strong agitation to ensure a good dispersion. A spoon or whisk will not be sufficient; an electric mixer is required for adequate dispersion.

Guar gum has the ability to thicken cold liquids but lumps can be formed when guar gum is added to a cold or room temperature liquid, so special attention is needed to achieve a homogeneous dispersion.

Useful Tip: If the recipe calls for other dry ingredients (e.g., sugar), we recommended mixing the guar gum with the dry ingredients before dispersion into the liquid to facilitate incorporation and prevent clumping.

ABOUT THE OBTAINED TEXTURE

Guar gum solutions thicken as they cool, and reach their optimal texture at very cold temperatures (about 4°C/39°F). The time needed to achieve the thickened texture corresponds to the time needed to cool the mixture.

Caution: We do not recommend covering the solution as it cools because the condensation of the evaporated water can form a film on top of the solution, which can become an area for microbial growth. However,

once the preparation has completely cooled, it should be covered to prevent cross-contamination and unwanted microbiological growth.

Guar gum produces a slight visible turbidity to the solution, so completely transparent preparations are not possible when using guar gum as a thickener.

To adjust or correct the texture, more guar gum can be added to the solution following the same method described previously. The preparation may be diluted with the addition of a small amount of the liquid (which does not contain any thickener). Neither of these corrections will alter the optimal organoleptic properties of the final preparation.

GUAR GUM BEHAVIOR WITH DIFFERENT FOODS

The formation of a thick solution depends on the characteristics of the original food product and on the concentration of guar gum added to the mixture. For example:

- With acidic foods ($\text{pH} < 2$): viscosity is decreased and may not occur at all. For example, when guar gum is added to vinegar, the mixture will not thicken correctly. We recommend increasing the concentration of guar gum when working with acidic liquids.
- Does not dissolve in oil. However, when guar gum is added to a solution of 50% oil and 50% water, a very stable emulsion forms.
- With alcoholic beverages: guar gum loses thickening properties, especially in liquids with high alcohol content.

Our studies on the behavior of guar gum with different food products demonstrated that guar gum is capable of producing a thickened preparation in nearly all of the cases studied (see Annex 2).

**HANDLING AND MANIPULATION OF FOODS
THICKENED WITH GUAR GUM**

SERVICE

A guar gum solution can be heated to 80°C/176°F, but at higher temperatures guar gum begins to lose its technological properties, such as its thickening capability.

Guar gum solutions may be reheated multiple times, though this process can increase the viscosity of the solution because of the water loss from evaporation.

Recommendation: If the dish is to be served hot, do not expect the texture to be the same as when the preparation is cold. The viscosity will be slightly reduced with the application of heat.

STORAGE

The shelf life of a preparation that has been thickened with guar gum depends primarily on the shelf life of the food product itself. The texture is not affected over time.

Recommendation: For health reasons, to avoid cross-contamination and microbiological growth, it is always advisable to cover the solution and store in the refrigerator.

Guar gum solutions can withstand the process of freezing and thawing without losing viscosity. Syneresis is observed after thawing in some cases, but the water is easily reincorporated into a homogenous mixture using simple agitation with a wire whisk.

**SYNERGISTIC EFFECTS WITH OTHER
THICKENING AGENTS**

There are no synergistic effects with other commonly used culinary texturizing agents that improve the thickening capacity of guar gum or that add any special properties. But the combination with xanthan gum should be considered to improve their thickening capacity.

**RICE MACARONI WITH VEGETABLES AND
BÉCHAMEL FOR HYPOCALORIC HOSPITAL DIETS**

ALÍCIA FOUNDATION

INGREDIENTS

400 g rice macaroni (gluten free)

500 g skim milk

0.7% guar gum (of liquid)

Salt, pepper, nutmeg

10 g extra virgin olive oil

Vegetables as desired

PREPARATION

Boil the macaroni for 7 minutes in salted water. Once cooked, cool macaroni as fast as possible.



FIGURE 3.13 RICE MACARONI WITH VEGETABLES AND BÉCHAMEL FOR HYPOCALORIC HOSPITAL DIETS.

Peel and cut the vegetables as desired.

Blanch vegetables in salted water and then rinse vegetables quickly with cold water cool them (to preserve the color).

Pour the guar gum into the skim milk and mix well with a hand blender. Bring to boil, stirring constantly. Add the salt, pepper, and nutmeg.

Sauté the vegetables in a hot skillet with the extra virgin olive oil, and add some salt.

Add the macaroni to the skillet and sauté together with the vegetables

Serve pasta and vegetables with the fat-free béchamel sauce

Guar gum produces a fatty mouth feel without the addition of fat and therefore works well as a substitute for fat in low-fat recipes.

TARA GUM

GENERAL INFORMATION

FEATURES AND USE

Tara gum has a strong thickening capacity and when used in combination with xanthan gum produces a soft, elastic gel.

TERMINOLOGY

Tara gum.

ORIGIN

Tara gum is extracted from the South American *Caesalpinia* tree.

NATURAL PROPERTIES

Tara gum is a carbohydrate. It is included in the family of galactomannans, along with locust bean gum and guar gum. Galactomannans contain both galactose and mannose units (different types of sugars).

FORM

Powder.

LEGAL INFORMATION

Tara gum is classified as an additive in Europe. The EU Code for tara gum is E-417.

KEY PROPERTIES

- Has properties of a hydrocolloid
- Used as a thickener and stabilizer
- Disperses in cold water but is hydrated in hot water and does not dissolve in oil
- Thickening capacity similar to guar gum and locust bean gum
- Produces soft textures that do not persist in the mouth and has a delicate mouthfeel

HISTORICAL NOTES

Tara gum is relatively new to the market compared with the other gums in the same family (guar gum and locust bean gum).

GENERAL APPLICATIONS

Food industry: Ice cream, soups, meats, and dairy products

Other: In the textile and paper industry (for its humectant properties); also used for water treatment

	g/100g
Protein (maximum)	3.5
Fiber (minimum)	78
Fat (maximum)	1

FIGURE 3.14 NUTRITIONAL VALUE OF THE TARA GUM USED.

ADDITIONAL INFORMATION

The tara tree is very similar to the Mediterranean carob tree, and the properties of tara gum are similar to those of locust bean gum. Tara gum is often used as a substitute for locust bean gum, as it is cheaper to produce but has similar properties.

CHARACTERISTICS OF THE SELECTED PRODUCT

The product we selected is highly refined and leaves no residual flavor in the final dish.

BASIC FEATURES

Information provided by the manufacturer.

- Particle size: > 125 microns 15% maximum
- < 75 microns 30–60%
- Humidity: Max. 15%
- pH: 4.–7.0 (1% aqueous solution)
- Viscosity (1% water solution with Brookfield RTV at 20 rpm)
- Viscosity at high temperature: 4500–5500 cps
- Viscosity at cold temperature: 3800–5000 cps

NUTRITIONAL VALUE

Information provided by the manufacturer.
(EU version)

There are no restrictions on consumption for people with restricted diets, and it does not contain allergens.

INSTRUCTIONS FOR USE**USING TARA GUM AS A THICKENER**

1. Add the tara gum to the liquid that is to be thickened, which should be at room temperature.
2. Mix well with a handheld electric mixer.
3. Bring to a boil, stirring constantly, then remove from heat.
4. Let cool completely to complete the hydration process.

WORKING WITH TARA GUM**CONCENTRATION**

The standard concentration for culinary use is between 0.25% and 1% solution of tara gum to the liquid to be thickened.

For example, the following textures are obtained in a 150 g water solution at room temperature (18°C/64.4°F) with the following concentrations of tara gum:

- 0.2%: mixture begins to thicken.
- 0.2% to 0.4%: low viscosity. Texture: SAUCE
- 0.5% to 0.7%: medium viscosity. Texture: SAUCE/CUSTARD
- 0.8% to 1%: high viscosity. Texture: THICK CREAM

The viscosity of the final product depends on the concentration of the thickener and the natural composition of the liquid that is to be thickened. The concentration of tara gum needed to achieve the desired outcome is determined by the original texture of the liquid.

The use of a handheld electric mixer is highly recommended because strong agitation is needed to disperse the tara gum into solution. Therefore, we recommend working with a minimum of 150 g of liquid in order to be able to use the mixer effectively.

TEMPERATURE

If the tara gum solution does not reach a minimum temperature of 85–90°C/185–194°F, hydration will not be complete and the thickening process will not develop correctly.

It is possible to achieve a partial hydration of tara gum without heating the solution. However, this method is not recommended because the final product will not obtain the maximum thickness that can only be obtained by heating the solution.

Although tara gum does not lose its ability to thicken when heated, the viscosity of the preparation decreases at high temperatures.

Warm the solution to the boiling point and then remove from the heat. This method ensures that the mixture has achieved the correct temperature throughout its volume and that the tara gum is fully hydrated.

If tara gum is added to a hot liquid, very strong agitation is required to ensure complete dispersion and to prevent the formation of lumps. High temperatures are ideal for proper hydration, but a hot dispersion can result in an uneven texture and subsequent partial hydration of the product, causing lumps to form.

DISPERSION/HYDRATION

Tara gum requires strong agitation to ensure a good dispersion. A spoon or whisk will not be sufficient; an electric mixer is required for adequate dispersion.

Tara gum has the ability to thicken cold liquids, but complete hydration will not occur. Many lumps form when tara gum is added to a cold or room-temperature liquid, so special attention is needed to achieve a homogeneous dispersion.

Useful Tip: If the recipe calls for other dry ingredients (e.g., sugar), we recommended mixing the tara gum with the dry ingredients before dispersion into the liquid in order to facilitate incorporation and prevent clumping.

When working with ingredients that are sensitive to oxidation or that have volatile aromas such as fresh fruit juices or flavored waters, the guar gum can be dispersed in only half of the solution and then added to the other half at room temperature while stirring gently with a wire whisk.

ABOUT THE OBTAINED TEXTURE

Tara gum solutions thicken as they cool and reach their optimal texture at very cold temperatures (about 4°C/39°F). The time needed to achieve the thickened texture corresponds to the time needed to cool the mixture.

Caution: We do not recommend covering the solution as it cools because the condensation of the evaporated water can form a film on top of the solution, which can become an area for microbial growth. However, once the preparation has completely cooled, it should be covered to prevent cross-contamination and unwanted microbiological growth.

Tara produces a slight visible turbidity to the solution, so completely transparent preparations are not possible when using guar gum as a thickener.

To adjust or correct the texture, more tara gum can be added to the solution following the same method described already. The preparation may be diluted with the addition of a small amount of the liquid (which does not contain any thickener). Neither of these corrections will alter the optimal organoleptic properties of the final preparation.

TARA GUM BEHAVIOR WITH DIFFERENT FOODS

The formation of a thick solution depends on the characteristics of the original food product and on the concentration of guar gum added to the mixture. For example:

- With acidic foods ($\text{pH} < 2$): viscosity is decreased and may not occur at all. For example, when tara gum is added to lemon juice, the mixture will not thicken correctly. We recommend increasing the concentration of tara gum when working with acidic liquids.
- Does not dissolve in oil. However, when tara gum is added to a solution of 50% oil and 50% water, a very stable emulsion forms.
- With alcoholic beverages: tara gum loses thickening properties, especially in liquids with high alcohol content.

Our studies on the behavior of tara gum with different food products demonstrated that tara gum is capable of producing a thickened preparation in nearly all of the cases studied (see Annex 2).

**HANDLING AND MANIPULATION OF FOODS
THICKENED WITH GUAR GUM****SERVICE**

Tara gum solutions can be heated to $80^{\circ}\text{C}/176^{\circ}\text{F}$, but at higher temperatures tara gum begins to lose its technological properties, such as its thickening ability.

Tara gum solutions may be reheated multiple times, though this process can increase the viscosity of the solution because of the water loss from evaporation. This can be easily corrected with the addition of water.

Recommendation: If the dish is to be served hot, do not expect the texture to be the same as when the preparation is cold. The viscosity will be slightly reduced with the application of heat.

STORAGE

The shelf life of a preparation that has been thickened with tara gum depends primarily on the shelf life of the food product itself. The texture does not change over time.

Recommendation: For health reasons, to avoid cross-contamination and microbiological growth, it is always advisable to cover the solution and store in the refrigerator.

Tara gum solutions remain stable without any major changes in viscosity after freezing and thawing. Syneresis is observed in some cases after thawing, but the water is easily reincorporated into a homogenous mixture using simple agitation with a wire whisk.

**SYNERGISTIC EFFECTS WITH OTHER
THICKENING AGENTS**

There is no known combination with another texturizing agent that improves the thickening capacity of tara gum. Tara gum can be combined with xanthan gum to produce gel, as mentioned previously in the section on xanthan gum.

CATALAN D.O.P. OLIVE OIL MEAT SAUCE

ALÍCIA FOUNDATION

INGREDIENTS

1000 g brown beef stock
200 g extra virgin olive oil (DOP Siurana)
0.3% tara gum



FIGURE 3.15 CATALAN D.O.P. OLIVE OIL MEAT SAUCE.

PREPARATION

Reduce the beef stock until desired concentration of flavor is obtained. Let cool to room temperature.

Add 0.3% tara gum to the stock and dissolve well with the help of a handheld electric mixer until no lumps are visible.

Transfer mixture to a saucepan and bring to boil, stirring constantly. Skim off any foam that forms on the surface.

Add the extra virgin olive oil and mix gently to not emulsify the mixture. (It should be a “broken” sauce.)

Serve with any meat or fish dish.

Watch Out: Tara gum allows you to thicken the beef stock without overly concentrating the flavor. Otherwise, the strong flavor of the beef stock can mask the aroma of the Siurana olive oil.



CHAPTER 4

Foaming Agents



GENERAL PROPERTIES OF FOAMING AGENTS

WHAT IS FOAM?

Foam is a colloidal dispersion of a gas in a liquid or a solid:

- In a liquid, foam is water (G/W) or oil (G/O), where G is the gas dispersed in water (W) or oil (O). Example: beer foam.
- In a solid, foam is G/S, where G is the gas dispersed solid (S). Example: soufflé, bread.

Culinary foams are generally very light in texture, though the texture can vary greatly depending on the prepared dish. Foams are typically produced with the help of an electric mixer, whisk, or whipping siphon, which are used to incorporate air into liquid food products and produce bubbles in different sizes. The whipping siphon requires nitrous oxide gas cartridges (chargers).

HOW DO FOAMING AGENTS WORK?

The foaming agents used in food preparation are surfactants, meaning that they lower the surface tension of water or of a solution.

In this case, the foaming agents reduce the surface tension between the gas bubbles and the liquid so that they become stable over time.

Because some of the foaming agents are hydrocolloids, they have dispersion and hydration requirements similar to those explained in the previous chapters about gelling and thickening agents.

There are other types of foaming agents with different properties and methods of use, which will be described in detail in this chapter.

The main requirement for a foaming agent is that it must provide enough air stability to last throughout the whipping process, producing a good overrun (foam volume) and an optimal consistency.

The functionality of a foaming agent (like all texturizing agents) greatly depends on its molecular structure, the concentration used, the temperature of use, the pH of the medium into which it is dispersed, the presence of salts in the medium, and the method of aeration, among other factors.

PRINCIPLE CHARACTERISTICS OF FOAMING AGENTS

A great variety of foaming agents are available, each with different properties of dispersion and hydration, as well as different methods of incorporating air, and they can produce very different textures.

[Figure 4.1](#) shows the most common products used to provide foamy or aerated texture in food and their main features and characteristics. Foaming agents are classified in block as emulsifiers because of their properties.

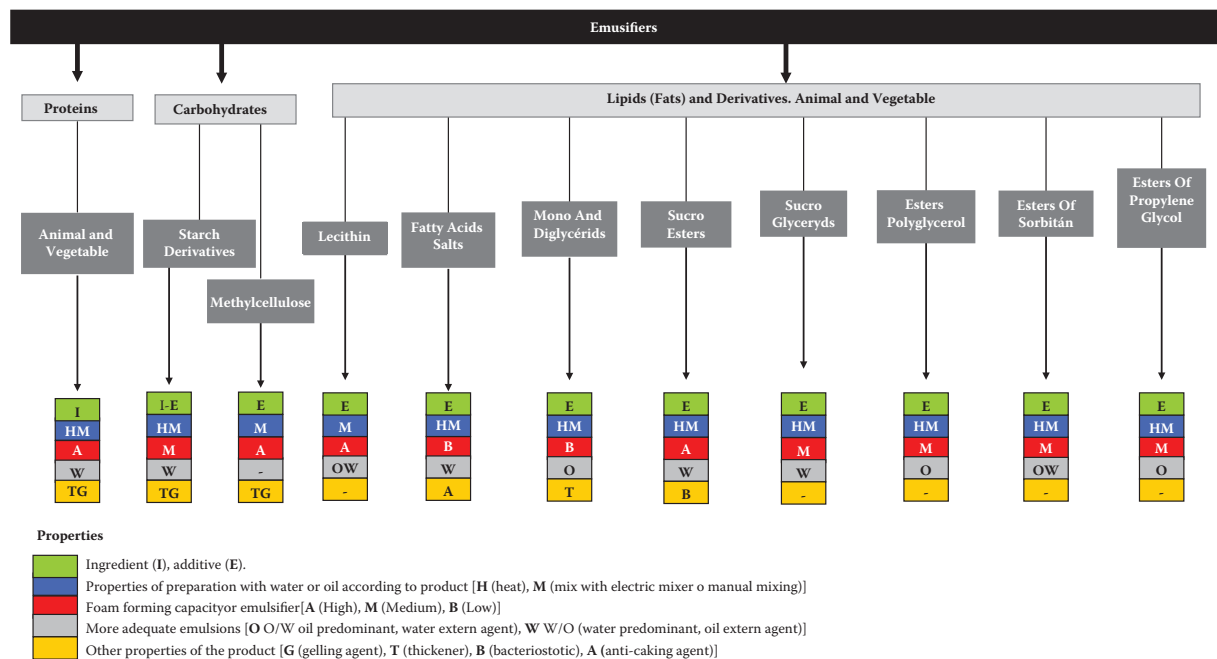


FIGURE 4.1 CHARACTERISTICS OF MAIN EMULSIFIERS.

PROPERTIES OF FOAMING AGENTS

Like previous examples of texturized liquids, the foaming effect depends on the type and concentration of foaming agent, and the equipment used to produce the foam.

The following categories are some of the most common types of equipment used to incorporate air in order to produce different effects. If the equipment is used properly and the concentration of the foaming agent is in the correct range, the following foams can be produced.

SIPHON

Produces foams with very small bubbles with a texture resembling shaving cream, thanks to the pressure generated from the siphon nozzle and the type of foaming agent used. Siphons can be used with a wide range of food products, and the resulting foams can be served hot or cold, depending on the type of foaming agent used. The gas comes from disposable N₂O (nitrous oxide) cartridges. The texture is similar to siphon foam or espuma.

STANDING ELECTRIC MIXER

The size of the air bubbles produced with an electric mixer varies depending on the mixing power, but standing mixers normally produce relatively small bubbles. The foam produced resembles meringue and is very stable. When foam is described as having a meringue texture, it does not necessarily mean that the foam was made with egg white, only that the texture is similar to meringue.

HANDHELD IMMERSION BLENDER

The texture produced by using a mixer to agitate the surface of the liquid is called froth or airs. Froth is very light, thanks to the large size of the bubbles, which resemble soap bubbles. Because of its special characteristic as the lightest possible foam, froth has a separate denomination.

There are other terms for describing foam texture (e.g., bubbles, clouds, and sponges), but the previous three are used most frequently for describing food preparations. As is typical in the culinary world, there is no consensus about naming these techniques, which has limited the words for describing foam textures to the previous three. Therefore, within each of the categories there is a significant range of possible textures. Though other devices or equipment can be used to prepare foam, such a blender for milkshakes, the final texture can still be placed in any of three categories (siphon foam, meringue, or froth).

This chapter does not address in deep on some of the secondary preparations that can be made with foams, such as frozen foams and froths, freeze-dried foams, and gelled foams, but in some cases any concern can be found to explain possibilities for certain applications.

ABOUT FOAMING AGENTS

This chapter describes the foaming agents that are most often used for culinary purposes. We describe their different characteristics and properties to provide a better understanding of how and when to use them. Please read the entire chapter, because you will find answers to the most common questions about each product. For each product we provide the following information.

DESCRIPTION OF HOW THE PRODUCT IS USED AS A FOAMING AGENT

In this section, we give a general overview of the foaming agent and its main characteristics, including origin, allergens, texture produced, and mouthfeel.

INSTRUCTIONS FOR USE

- Information on preparation and handling of the foaming agent to obtain desired texture: This section provides information on how to obtain foam based on the specifications of use for each of the

foaming agents. We describe the steps and the necessary proportions, as well as proper handling and best practices for achieving optimal results:

- Guidance about the minimum and maximum amounts of foaming agent required for different preparations and the equipment needed to obtain them.
 - Minimum amount of liquid necessary to obtain good results, taking into account the type of equipment or utensil used.
 - Temperatures required for each step of preparation and how to apply very precise temperatures if needed.
 - Whether the foaming agent needs strong, medium, or no agitation for good dispersion, which will determine the equipment needed for subsequent hydration.
 - Mixing time required for foam to achieve desired texture.
- Information about the characteristics of the resulting foam: foods with which foams can be prepared and what can be done to improve the outcome if the texture does not meet expectations.
 - Observations about how foaming agents work with different liquids and concentrations required according to type of liquid.
 - Description of types of foam obtained for each concentration and utensil.
 - What happens when too much or not enough foam is produced.
 - Suggestions for how to improve foams.
 - Information about foam preservation and storage conditions:
 - Duration of time that foam will retain the same or similar features. Description of ideal storage conditions.
 - Information about appropriate service temperatures for each of the foams described, best uses for each type of foam, and how long foam bubbles will last.
 - Whether or not the foaming agent may be frozen and thawed (maintaining the same flavor and texture characteristics).
 - Whether or not the foam is irreversible or if it can be formed a second time.

- Information about potential synergistic effects from combinations with other texturizing agents to improve results or for other applications.
- Common synergistic combinations with other texturizing agents or emulsifiers that improve results by adding stability to the foam, adding heat resistance, or increasing other texture effects.

Throughout the usage instructions, we emphasize certain information with the following indications:

Recommendations: special usage advice.

Caution: potential risks associated with process.

Useful Tips: suggestions for methods and procedures.

PRINCIPLE CULINARY USES FOR FOAMING AGENTS

A large variety of culinary preparations are possible, thanks to the wide range of foaming agents and techniques available. [Figure 4.2](#) summarizes the possible textures and preparations for each of the foaming agent considered in this chapter.

The textures presented in [Figure 4.2](#) are a random sample of different possibilities that can be achieved with a product to provide an idea of the different possibilities to be done. These are not necessarily the only textures that can be produced or the appropriate names for them; these are only examples and can vary depending on many different factors.

These examples of how texturizing agents can be used provide a guideline for further experimentation. Of course, the real range of possibilities is much too great to fit into a summary figure.

		Textures*												Elaborations**							General Concept			
		Sauce	Sauce	Nectar	Liquid Cream	Thick Cream	Puree	Texture Flan	Gelee	Nappage	Air	Soft Meringue	Hard Meringue	Marmalade	Aspic	Wrap	Jelly Bean	Mousse	Espuma	Sherbet	Suspension Effect	Technique	Cold Elaboration	Warm Elaboration
Foaming Agents	EGG White Powder	×	×	×	×	×	×	×	×	×	✓	✓✓	✓✓	×	×	×	×	✓✓	✓✓	✓	×	×	✓	✓
	Gelatin	✓	✓	✓	✓	✓	✓	✓✓	✓✓	✓	×	✓	✓✓	✓	✓✓	✓	✓✓	✓✓	✓✓	✓	×	×	✓✓	×
	Lecithin	×	✓	×	×	×	×	×	×	×	✓✓	×	×	×	×	×	×	×	✓	×	×	×	✓	✓
	Methylc Ellulose	×	×	×	×	×	×	✓	✓✓	✓	×	✓	✓	×	✓	×	×	✓	✓	×	×	×	✓	✓✓
	Sucroes Ter	×	✓	×	×	×	×	×	×	×	×	✓✓	×	×	×	×	×	×	✓	✓	×	×	✓	×

✓✓	It is very appropriated.
✓	It can be used.
×	Not applicable

FIGURE 4.2

EGG WHITE POWDER

GENERAL INFORMATION

FEATURES AND USE

Egg white powder is used to make aerated dishes and functions as a gelling agent when heated. Egg white powder can be used to make meringues, in which the liquid to be processed takes the place of the natural liquid of the egg whites.

TERMINOLOGY

Egg white powder, albumin powder.

ORIGIN

Different industrial methods are used to separate egg whites and dehydrate them to powdered form.

NATURAL PROPERTIES

Animal protein.

FORMS

Powder, with different particle sizes available.

LEGAL INFORMATION

Egg white powder is classified as a culinary ingredient, with no limitations on use or consumption.

KEY PROPERTIES

- Egg white powder is a foaming agent, but it also has emulsifying properties in liquids that contain fat.
- Egg white powder can leave a strong residual flavor in the foam it produces, depending on the food product used. The residual taste can be masked by large amounts of air in the final preparation. The strong residual taste can become a significant factor when choosing egg white powder as a foaming agent.
- Egg white powder foams have a smooth and long-lasting mouth-feel similar to that of a traditional meringue made with fresh eggs.

HISTORICAL NOTES

Egg white powder was developed by the food industry as dehydration technology in the mid-twentieth century.

GENERAL APPLICATIONS

Food industry: clarifying wines, juices, and broths; food supplements; desserts and pastries (marzipan, creams)

Other: Formerly used in traditional photography (albumin print)

ADDITIONAL INFORMATION

The egg white studied here is in powder form, but it should be noted that liquid egg white is often used to prepare foams. Egg white powders with added sugars, such as maltodextrins, are also commercially available. (The added sugars must be taken into consideration when determining the concentration of foaming agent to use).

CHARACTERISTICS OF THE SELECTED PRODUCT

The product selected was composed only of egg white powder with no added ingredients and therefore leaves some residual flavor in the foam.

BASIC FEATURES

Information provided by the manufacturer.

- Water content: 8% maximum
- pH: 5.5–8, in aqueous solution

NUTRITIONAL VALUE

Information provided by the manufacturer.
(EU version)

Powdered egg whites are essentially animal protein, and people with certain diet restrictions or egg allergies should avoid consumption.

INSTRUCTIONS FOR USE

HOW TO USE POWDERED EGG WHITES AS A FOAMING AGENT

We primarily studied the method for preparing powdered egg white foams using a standing electric mixer. There are other methods, however, such as using an immersion blender or whisk.

Energy kcal/100g	368
	g/100g
Protein (mínimum)	80
Carbohydrate	0.1

FIGURE 4.3 NUTRITIONAL VALUE OF THE EGG WHITE POWDER USED.

**STEPS FOR MAKING AN EGG WHITE POWDER
FOAM USING A STANDING MIXER**

1. Add the powdered egg whites to the liquid that is to be foamed at room temperature.
2. Mix well with an immersion blender and place in the refrigerator for at least 30 minutes to hydrate the egg white powder.
3. Beat mixture in the bowl of a standing mixer on medium speed until it achieves the desired texture. The mixing speed determines the size and the homogeneity of the bubbles that form and the consequent stability of the foam.

WORKING WITH POWDERED EGG WHITES**CONCENTRATION**

The basic concentration of egg white powder used and the characteristics of the resulting preparation both depend on the equipment that is used to produce the foam.

The typical concentration range is between 2% and 8% albumin powder to the total liquid. The wide concentration range takes into account liquids that have natural foaming ability (beets and licorice, for example). The concentration of egg white powder can be reduced in those cases, to avoid excess residual flavor. The maximum concentration (8%) is necessary for liquids without any foaming capacity, such as water.

The texture produced with egg white powder is called meringue not only because it is made with egg whites but also because the result is very similar to traditional meringue (though the color may vary depending on the liquid used).

Useful Tip: Once the foam is prepared, it can be manipulated like a traditional meringue. For example, it can be dehydrated to produce the same dry texture as French meringue.

The minimum amount of liquid necessary to produce foam with egg white powder is determined by the equipment used. With a standard mixer (common in home kitchens), a minimum of 300 g of liquid is

needed for the foam to form correctly. With the larger equipment used in professional kitchens, the minimum amount of liquid is determined by container size and mixing capacity. A siphon requires a minimum of liquid equal of half the volume of the container.

TEMPERATURE

Egg white powder does not require specific temperatures to produce foam and can create foam in both warm and cold liquids. The temperature must be less than 65°C/149°F, however—the point at which protein denaturation occurs) to prevent improper formation of the foam and the possibility of lumps from coagulation of the albumin.

Useful Tip: If the liquid into which the egg white powder is dispersed is stored in the refrigerator at 8°C/46.4°F for 8–12 hours the stability and firmness of the foam will improve as the egg white powder fully hydrates. This works only with liquids that can be stored in this way and does not work with fresh juices or other liquids that oxidize over time. For those liquids we recommended the minimum rest time of 30 minutes in the refrigerator.

DISPERSION/HYDRATION

Once the egg white powder is hydrated in the liquid, it reacts the same way fresh egg whites react to agitation. This means that just like a traditional meringue made with liquid egg whites, too much mechanical work can break the foam produced with powdered egg whites. Although powdered egg whites have significantly more resistance to overmixing than natural egg whites, the mixing time depends on the characteristics of the liquid as well as the mixing speed.

Caution: If necessary, the mixing process can be interrupted and restarted without breaking the foam provided that the “soft-peak” stage has not yet been reached.

ABOUT THE OBTAINED FOAM

As indicated already, the foams produced with powdered egg white have technological properties similar to those of traditional

meringues, though the appearance and stability of the final result depend largely on the nature of the food product used. Therefore, once the foam is produced, we do not recommended further mixing. Even if the foam could reform it would be very unstable, and a resting period or the addition of more egg white powder will not help. Furthermore, once the foam has formed, additional egg white powder or other emulsifiers or stabilizers should not be added because the air bubbles in the mixture will prevent them from dispersing and hydrating correctly.

Caution: The addition of more foaming agent will not add stability to the foam if the food product itself is destabilizing the foam.

BEHAVIOR OF EGG WHITE POWDER WITH FOODS

The food that is to be foamed should have sufficient water content for the egg white powder to disperse properly. Furthermore, if the liquid is viscous it may be too heavy for the foam to form correctly.

The natural properties of the liquid can provide other limitations that must be taken into account when planning the preparation. For example:

- Salt does not affect foam formation.
- Foam will not form properly with high acid ($\text{pH} < 2$) foods like lemon juice.
- Powdered egg white foams prepared with sugary liquids have greater stability.
- Foam is more difficult to achieve with alcoholic beverages, usually due to poor hydration.
- Foams may have difficulty forming in the presence of fat (even very small amounts).

Egg white powder was capable of producing foam in almost all of the food products that we tested (see Annex 3).

HANDLING AND MANIPULATION OF EGG WHITE POWDER FOAMS

SERVICE

Foams produced with powdered egg white under optimal conditions will have the same stability over time as traditional meringues without sugar.

Caution: A powdered egg white foam without added sugar will not last for more than 20 minutes, so it should be prepared immediately prior to serving (as the preparation process is relatively fast).

The foam will stabilize at high temperatures because of protein coagulation, so this possibility should be considered when planning how the dish will be served, taking into account logical texture changes. Egg white powder foams can also be dehydrated in a low temperature oven or with a dehydrator.

Egg white powder foams can withstand high temperatures, between 50°C/122°F and 80°C/176°F.

Recommendation: Egg white powder foams can be dehydrated to produce a texture similar to French meringue. Dehydrated foams have a long shelf life if stored correctly (airtight container in a cool area with no humidity).

Caution: Dried foams are very sensitive to moisture and quickly trap any available water molecules from the atmosphere, producing an undesired softening and rubbery texture.

STORAGE

As mentioned already, foams with a high percentage of sugar are more stable, so adding sugar is recommended if the foam needs to withstand manipulation or a long service period.

Egg white powder foams can be frozen but must then be served frozen. The structure will break as the foam warms up if it is not stabilized with a gelling agent such as gelatin.

Recommendation: We recommend rapid (flash) freezing rather than the conventional freezer. Rapid freezing produces smaller ice crystals, which have less effect on the structure of the foam.

SYNERGISTIC EFFECTS WITH OTHER THICKENING AGENTS

To improve the stability of the resulting foam, egg white powder can be combined with the following:

- A small percentage of xanthan gum
- Gelatin for maintaining the structure, though the texture will vary and light gelling can occur at colder temperatures

INTERPRETATION OF VANITY: CHOCOLATE CAKE WITH ALMOND CREAM AND COCOA BUBBLES

LUIS ANDONI ADURIZ, MUGARITZ RESTAURANT (RENTERÍA)

CHOCOLATE MOUSSE

Ingredients

1 vanilla bean
95 ml cream
95 ml milk
52 g inverted sugar
450 ml cream
250 g 70% couverture chocolate
95 g egg yolks

Preparation

Split the vanilla bean in half, and use the point of a sharp knife to scrape out the seeds. Add the seeds and the pod to 95 ml of cream. Add the milk and the inverted sugar, and heat briefly to infuse the vanilla. Store in the refrigerator for 12 hours.

Place 250 ml of cold cream in a bowl. Whip the cream.

Break the chocolate into small pieces.

Gently whisk the egg yolks and pour them into the vanilla/milk infusion (remove vanilla bean pod). Place this mixture in a double boiler until it reaches 85°C (185°F), then pour it over the chocolate. Place the mixture in a blender with a heating element. Blend the preparation gently at 30°C (85°F) to obtain a smooth ganache. Add a small portion of the whipped cream to the ganache and carefully fold it in with a silicone spatula. Add the chocolate mixture to the rest of the whipped cream and fold gently to obtain a smooth and glossy cream.

ALMOND MILK

Ingredients

500 ml milk

250 g Marcona almonds

Preparation

Process the milk and the almonds in a blender. Strain through a fine mesh strainer and then cover and refrigerate the strained liquid.

SPONGE CAKE

Ingredients

80 g egg yolks

125 g sugar

30 ml water

125 g egg whites

110 g flour

15 g unsweetened cocoa powder

Salt

Preparation

Put the yolks into a mixer with half of the sugar and beat. Gently heat the water and add it gradually to the egg yolk mixture.

Whisk the egg whites separately. Once they are forming soft peaks, add the remaining sugar and beat until stiff peaks form (meringue). Carefully add the beaten yolks to the meringue. Sift the flour and gently fold it into the meringue.

Fold in the cocoa powder and salt. Pipe the meringue mixture into thin layers onto a parchment-lined baking sheet.

Bake at 250°C/482°F for 5 minutes.

Allow to cool and set aside.

RUM SYRUP

Ingredients

14 ml rum

65 ml water

17 g sugar

5 g glucose

Preparation

Combine the water, sugar, and glucose in a saucepan and bring to a boil. Cool and add the rum. Cover and refrigerate.

BLACK GLAZE

Ingredients

10 sheets leaf gelatin

290 ml water

360 g sugar

10 ml powdered milk

120 g unsweetened cocoa powder

240 ml cream

Preparation

Hydrate the gelatin sheets in cold water and then dry them between two paper towels.

Heat the water with the sugar and the powdered milk and stir well. When the mixture is hot and the powdered milk has dissolved, add the powdered cocoa and cream. Heat the mixture to 102°C/215°F. Remove pan from the heat.

Once mixture has cooled to 50°C/122°F, gently mix in the gelatin (without stirring too much so as not to create bubbles).

GLAZED SPONGE CAKE

Ingredients

Sponge cake (previously prepared)

Rum syrup (previously prepared)

Chocolate mousse (previously prepared)

Black glaze (previously prepared)

Preparation

Cut the sponge cake into rectangles 7 cm long, 1 cm wide, and 1 cm high.

Immerse the cake “ingots” in the rum syrup for 20 minutes, and then remove from the syrup and drain them on a cooling rack.

Place the chocolate mousse into rectangular silicone molds 8 cm long, 3 cm high, and 3 cm wide to a depth of 1 cm. Carefully place one rum-soaked cake “ingot” into each mold. Add more chocolate mousse up to the rim of the mold and cover the filling with another soaked cake strip. Refrigerate.

Gently heat the black glaze until it melts; it should reach 32°C (90°F). Unmold the mousses and coat the tops of the “ingots” with the glaze.

Cocoa Bubbles

Ingredients

100 g unsweetened cocoa powder

1 liter still mineral water

20 g powdered egg white

100 g white sugar
0.5 g salt
1.2 g xanthan gum

Preparation

Combine the cocoa with the mineral water in a bowl and mix gently.

Do not allow the mixture to foam.

Pass the mixture through a fine sieve into a blender. Blend the preparation very gently.

Gradually add the egg white powder, sugar, and salt, mixing constantly until it has an even consistency and the added ingredients are hydrated.

Gradually add the xanthan gum and continue to mix in the same way for a further 10 minutes at a low speed.

Vacuum pack the mixture to remove any bubbles that may have formed.

Refrigerate.

ALMOND CREAM**Ingredients**

200 mL almond milk (previously prepared)
10 g kudzu starch
5 g sugar
Salt

Preparation

Put the almond milk into a pan and mix the kudzu starch into it.

Add the sugar and a little salt. Place the pan over a very low heat and stir with a silicone spatula. Do not let the mixture stick to the bottom. Remove it from the heat when it has acquired a creamy, sticky texture. Chill mixture in an ice water bath (bain-marie), and then place it in a disposable pastry bag and refrigerate.

GOLD NUANCES

Edible gold dust

Vodka

Mix the gold with the vodka and pour the liquid into an airtight container.

FINISHING AND PRESENTATION

Paint the border of the plate with the gold liquid and let dry.

Position a serving of the glazed sponge cake on the plate and place a spoonful of almond cream to the side.

Place a small amount of the cocoa bubble mixture on the base of the plate.

Put the remaining cocoa bubble mixture into a bowl. Inject air using an aquarium pump. Stable and resistant bubbles will form on the surface of the liquid. Collect the bubbles with a slotted spoon and transfer them to the plate.



FIGURE 4.4 INTERPRETATION OF VANITY: CHOCOLATE CAKE WITH ALMOND CREAM AND COCOA BUBBLES.

GELATIN

GENERAL INFORMATION

FEATURES AND USE

Gelatin foams that are light and stable at cold temperatures. Gelled foams can withstand some manipulations such as cutting, molding, or breading and can even support a small amount of weight (e.g., other ancillary elements in a dish).

TERMINOLOGY

Gelatin is also known as fish gelatin, or *cola de pescado* (fish tail) in Spanish, because gelatin was historically obtained from fish and also because gelatin sheets can resemble fish scales.

ORIGIN

Gelatin is obtained from the physicochemical extraction of collagen from animal bones and skin, mostly from pigs but also from cows. Gelatin obtained from fish is also available for certain religious observations.

NATURAL PROPERTIES

Gelatin is made of animal protein.

FORMS

Powder or sheets (leaf gelatin).

LEGAL INFORMATION

Food-grade gelatin is classified as a culinary ingredient, with no limitations on use or consumption.

KEY PROPERTIES

- Properties of a hydrocolloid.
- Typically used as a gelling agent, but is also effective as emulsifying and foaming agent.
- Does not dissolve in oil.
- Leaves no residual taste in foams that are produced that regular concentrations.
- Foams melt in the mouth. Human body temperature (37°C/98°F) is greater than the melting point of gelatin foams, so they do not last long in the mouth and have a pleasing mouth feel.
- Powdered gelatin available in a pregelatinized form, which has been treated so that the gelatin can be hydrated without the application of heat.

HISTORICAL NOTES

Although the ancient Egyptians discovered gelatin, it was not until the late seventeenth century that gelatin began to be extracted from animal bones. Until recently, gelatin was used almost exclusively in Western cultures.

GENERAL APPLICATIONS

Food industry: dairy desserts, pastries, meats, product restructuring, etc.

Other uses: pharmaceutical preparations such as excipients, capsules and tablets, and the photography industry

ADDITIONAL INFORMATION

The gelling strength of gelatin is measured in degrees Bloom. Bloom values typically range between 75 and 300, with 220 Bloom gelatin sheets being the most commonly available. Higher Bloom numbers produce stronger gels.

CHARACTERISTICS OF THE SELECTED PRODUCT

We tested leaf gelatin (sheet form) because it is one of the most commonly used forms of gelatin in the kitchen, it disperses easily, and unlike most foaming agents it does not leave an aftertaste.

BASIC FEATURES

Information provided by the manufacturer.

- 220 Bloom per sheet
- Each sheet weighs 2 grams

NUTRITIONAL VALUE

Information provided by the manufacturer.
(EU version)

Gelatin sheets consist mainly of animal protein and should therefore be avoided by people with certain dietary restrictions.

	g/100g
Carbohydrate soluble fiber	0
Protein	84.4
Fat	0
	mg/100g
Sodium	32
Potassium	22
Magnesium	11
Calcium	11

FIGURE 4.5 NUTRITIONAL VALUE OF THE GELATIN USED.

INSTRUCTIONS FOR USE

HOW TO PREPARE GELATIN FOAMS

There are two methods for preparing gelatin foams: with a siphon or with a standing electric mixer.

Method A: Gelatin Foam with a Siphon

1. Add the gelatin sheets one at a time (with dry hands) to a cold water (or ice water) bath and place in the refrigerator for at least 5 minutes.
2. Carefully remove the gelatin sheets from the water bath and dry them with a paper towel to remove excess water.
3. Add the gelatin to a saucepan with part ($\frac{1}{4}$ or $\frac{1}{3}$) of the liquid to be foamed.
4. Bring the mixture to 40–50°C/104–122°F, until the gelatin sheets melt/disintegrate in the middle.
5. Remove from heat. Use a whisk to mix the gelatin mixture with the remaining liquid. Pass mixture through fine mesh strainer to remove any lumps or impurities.
6. Pour mixture into siphon until $\frac{3}{4}$ full.
7. Load one or two charges of nitrous oxide (N_2O) gas in the siphon: one charge for a 500 mL siphon and two charges for a 1 liter siphon, on average.
8. Shake the siphon vigorously.
9. Chill the siphon in the refrigerator for at least 3 hours.
10. Shake again before using.
11. Dispense foam from siphon at the time of service.

Method B: Gelatin Foam with a Standing Mixer

1. Add the gelatin sheets one at a time (with dry hands) to a cold water (or ice water) bath and place in the refrigerator for at least 5 minutes.
2. Carefully remove the gelatin sheets from the water bath and dry them with a paper towel to remove excess water.

3. Divide the liquid that is to be foamed into two parts: a large portion ($\frac{3}{4}$) and a small portion ($\frac{1}{4}$) (small portion should be at least 50 ml).
 - a. In a saucepan, mix the hydrated gelatin with the remaining liquid ($\frac{1}{4}$) and bring the mixture to 40–50°C/104–122°F, until the gelatin sheets start to melt/disintegrate in the middle. Remove from heat and cool to approximately 15°C/59°F.
 - b. Pour the larger portion ($\frac{3}{4}$) into the bowl of a standing mixer (liquid should be at a temperature of 8–10°C/46.4–50°F). Mix on medium speed.
4. Pour the gelatin mixture into the mixer with the remaining liquid.
5. Beat at medium speed for about 10 minutes, or until desired texture is obtained.

WORKING WITH GELATIN

CONCENTRATION

The concentration of gelatin required as well as the characteristics of the final dish both depend on the equipment that is used to produce the foam and the specific food product.

For Method A: Gelatin Foam with a Siphon

4 to 10 sheets/liter of gelatin is the typical concentration range for culinary purposes.

The foam obtained is classified as: SIPHON FOAM

For Method B: Gelatin Foam with a Stand Mixer

The basic concentration range for culinary use is 6 to 10 gelatin sheets/liter.

The obtained foam is categorized as: SOFT MERINGUE/MOUSSE

The wide concentration range in both cases reflects the fact that some products have natural foaming power (e.g., beets and licorice), and in these cases only a minimum amount of gelatin is necessary. The maximum concentration (10 leaves per liter) is required for liquids such as water that do not have any foaming capacity.

The minimum amount of liquid depends on the type of equipment used to produce the foam.

For Method A: Gelatin Foam with a Siphon

A minimum amount of liquid equal to half the volume of the container is necessary. A standard siphon should be filled at least to the halfway point and no more than 3/4 full, so a ½ liter capacity siphon requires a minimum volume of 250 ml of liquid.

For Method B: Gelatin Foam with a Stand Mixer

For a standard capacity countertop mixer (home kitchen size), a minimum of 300 g of liquid is required for the foam to form correctly. For larger capacity professional mixers, the minimum amount of liquid necessary should be calculated based on container capacity and mixing power.

TEMPERATURE

For Method A: Gelatin Foam with a Siphon and for Method B: Gelatin Foam with a Stand Mixer

The gelatin sheets for hydration must be presoaked in water (for hydration to occur). We do not recommend using the liquid that is to be foamed to soak the gelatin, as certain properties of the liquid could prevent the gelatin from fully hydrating.

Full dispersion of the gelatin into solution requires a minimum temperature of 40°C/104°F, and subsequent gelling requires cooling the mixture to 8°C/46.4°F.

Caution: During the dispersion of the gelatin into the hot liquid, the temperature should remain below 100°C/212°F or the gelatin can lose its technological properties, such as its foaming capacity.

Furthermore the evaporation of liquid at high temperatures can alter the concentration of gelatin to liquid, resulting in foam that is overly gelled.

Caution: When using a standing mixer, the ambient temperature of the work area can greatly influence the foaming process. Kitchen temperatures of 35°C/95°F or higher can prevent the gelatin from producing foam correctly. If the ambient temperature is very cold, gelling can occur before the air has been incorporated into the mixture, resulting in foam that is too compact and heavy.

DISPERSION/HYDRATION

The gel does not need strong agitation for dispersion. Gentle mixing with a whisk, spoon, or other kitchen utensil is sufficient.

Once the gelatin is integrated into the liquid at 40°C/104°F it is ready for use in a standing mixer (for Method B) or in a siphon (for Method A).

For Method B: Gelatin Foam with a Stand Mixer

Once the gelatin is hydrated and added to the mixer, excessive mechanical work can break the resulting foam. Special care must be taken to stop the mixer at the correct time because if the foam breaks it cannot reform.

Useful Tip: the mixer speed will determine the size and homogeneity of the bubbles and therefore the stability of the foam, so it is important to use moderate speed.

ABOUT OBTAINED FOAM

FOR METHOD A: GELATIN FOAM WITH A SIPHON

Foams produced with a siphon have short shelf lives, which vary according to the food ingredient and the concentration of gelatin used. For example, foam that is made with cream in addition to gelatin will be more stable than foam prepared with a liquid such as a fruit juice or an alcoholic beverage.

Foams lose their structure rapidly in warm ambient temperatures, so the foam should be the last element added to the plate before service, if possible.

When there is an excess of gelation, a firm gel can occur inside of the siphon, impairing correct application. One way to solve this problem is to let the siphon sit out at room temperature. If the problem persists, remove the gas and the head of the siphon, and extract the gelatin to remelt into it and dilute it with a little more of the liquid.

Useful Tip: We recommend testing the quality of the foam after it rests and before it is served to correct any application or stability problems that might have occurred.

Caution: In some cases, adding more gelatin does not make the foam more stable, as certain food products can destabilize the foam.

FOR METHOD B: GELATIN FOAM WITH A STAND MIXER

Foams prepared with a stand mixer can be served immediately after aeration (15–20 minutes) as fluid foam or can be placed into a mold and gelled in the refrigerator. If the foam has the correct amount of gelatin, it can then be cut with a knife into desired shapes and served cold, which allows it to be used in many interesting ways.

When problems occur (e.g., failure of the foam to form, loss of structure after resting, or other mishaps), adding more gelatin will not help because it is too difficult to completely remove the air from the emulsion.

BEHAVIOR OF GELATIN WITH DIFFERENT FOODS

Results vary depending on the characteristics of the food product and on the concentration of gelatin used. It is very important to take into consideration the properties of each ingredient.

The food product must have high water content for the gelatin to disperse properly, and if the liquid is too viscous it will be difficult to whip and incorporate air.

Examples of food composition and resulting foam performance are as follows:

**For Method A (Gelatin Foam with a Siphon) and
for Method B (Gelatin Foam with a Stand Mixer):**

- Salt content of the mixture does not affect foam formation.
- Foam does not form properly with high acid ($\text{pH} < 2$) foods such as lemon juice.
- Foam is more difficult to achieve with alcoholic beverages, which can interfere with hydration.
- If the mixture is high in fat (or in some cases even with small amounts of fat), air incorporation can be impaired.

We observed the behavior of leaf (sheet) gelatin with a variety of food products. Gelatin was able to produce foam in almost all cases (see Annex 3).

Caution: Hydration is difficult with food products that have low water content or are high in fat, and therefore the foam may not form properly.

Useful Tip: If the food product itself has some foaming ability of its own (e.g., beets and cream), foam production is much easier and a smaller amount of gelatin is needed.

HANDLING AND MANIPULATION OF GELATIN FOAMS

SERVICE

**For Method A (Gelatin Foam with a Siphon) and
for Method B (Gelatin Foam with a Stand Mixer)**

Gelatin foams melt at $30^{\circ}\text{C}/86^{\circ}\text{F}$, so they cannot be served hot. If the plating dish is hot for some reason, the foam will collapse very quickly, significantly limiting the service time.

In the case of Method A, the foam is applied to the plate immediately before service and cannot be applied earlier as it will lose its structure.

With Method B, the foam structure is gelled and has a longer shelf life. However, it can still melt in warm ambient temperatures, so we still recommend adding the foam just before serving.

Caution: Take care not to manipulate the foam with warm hands or any tool that has a temperature of 30°C/86°F because the gel will melt at this temperature.

STORAGE

For Method A (Gelatin Foam with a Siphon) and for Method B (Gelatin Foam with a Stand Mixer)

Gelatin foams must be stored in a cool place, at temperature below 30°C/86°F (preferably in the refrigerator) until ready to serve, or they will melt.

If using a siphon, the siphon must remain refrigerated until just before serving.

As indicated already, with both methods the lifetime of gelatin foam is only a few minutes, so the foam should be prepared right before the dish is served. Gelled foams prepared with a standing mixer are the exception, as these have an optimal stability of about 4 hours if stored in the refrigerator (covered so as not to absorb odors).

Useful Tip: It is possible to dehydrate foams to obtain a dry texture similar to a French meringue, which results in a much longer shelf life. Dehydrated foams should be stored in a closed container in a cool area free of moisture. Dried foam is very sensitive to moisture and traps any water molecules available in the atmosphere, resulting in a loss of the dry texture.

Gelatin foams can be frozen to produce surprising textures but then must be served frozen as the thawing process breaks their structure.

Recommendation: We recommend using a blast chiller rather than a conventional freezer. Rapid freezing produces smaller crystals, which are less likely to affect the structure.

SYNERGISTIC EFFECTS WITH OTHER FOAMING AGENTS

There are no synergistic effects with other commonly used foaming agents that improve the thickening capacity or other actions of gelatin.

MIMETIC BANANA WITH MANGO AND NUTMEG

SERGIO Y JAVIER TORRES RESTAURANT DOS CIELOS (BARCELONA)

MOLD

Banana peels coated with a thin layer of tempered white chocolate (13% cocoa butter).

BANANA CREAM**Ingredients**

240 g cream
20 g milk
90 g glucose
75 g dextrose
60 g sugar
5 g neutral for creams
7 g leaf gelatin
30 cl natural lemon juice
480 g ripe banana

Preparation

Heat the milk and the cream to 40°C/104°F, mixing well.
Bring mixture to 95°C/203°F and then remove from heat. Stir in the gelatin (previously hydrated). Let mixture cool and gel.
Freeze the peeled bananas in a vacuum bag.
Put the mixture into a Thermomix, add the lemon juice and frozen bananas, and mix until smooth.

Strain the mixture and place in a pastry bag. Pipe mixture into the molds, filling them almost full, leaving a couple of millimeters of space in the molds.

BANANA, MANGO, AND PASSION FRUIT GELÉE

Ingredients

80 g banana pulp
40 g mango pulp
55 g passion pulp
2 g leaf gelatin

Preparation

Heat the passion fruit pulp to 60°C/140°F. Add the gelatin (previously hydrated) and stir gently until melted. Add banana and mango and mix well.

NUTMEG CRUMBLE

240 g butter
16 g salt
270 g sugar
310 g almond powder
180 g flour
20 g ground nutmeg

Preparations

Mix dry ingredients together.

Cut the butter into cubes about 0.5 cm square.

Mix the cold butter cubes into the dry ingredients until mixture is crumbly.

Spread on a baking sheet and bake at 160°C/320°F for 13 minutes.

MANGO VANILLA BRUNOISE

Finely dice the mango. Dry mango slightly on paper towels. Crush a portion of the mango with some vanilla.

COCONUT CAKE**Ingredients**

400 g egg whites
0.8 g albumin
260 g sugar
80 g cornstarch
170 g grated coconut
140 g coconut pulp

Preparation

Beat the egg whites at room temperature with the albumin, gradually adding the sugar in three parts.

Process the cornstarch with the shredded coconut until it has a fine, flour-like texture.

Gently mix the coconut into the meringue. Carefully fold in the dry ingredients.

Line a Gastronom with greaseproof paper and plastic wrap. Pour batter into the pan.

Bake in a steam oven 98C°/208°F for curing 49C°/120°F.

Mango Sorbet**Ingredients**

100 g glucose
1000 g water
480 g sugar
10 g citric acid
10 g neutral sherbet
2000 g ripe mango pulp

Preparation

Heat the water and citric acid to 40°C/104°F. Add the sugar, sherbet, and mango pulp and bring mixture to a boil.

Allow mixture to cool. Vacuum pack the mixture and let nature handle grow 8 hours (set aside for 8 hours).

Freeze the mix in the pacojet container. (Freeze the mixture in Pacojet container. Once frozen, use Pacojet to puree mixture.)

CARAMEL BANANA CRUNCH**Ingredients**

100 g fondant

50 g glucose

60 g isomalt sugar

60 g banana pulp

Preparation

Make a syrup with sugar, heating it to 160°C/320°F. Remove from heat and mix with banana pulp. With the cold caramel, mix the same until it is dust. (Let caramel cool then pulverize it into crumbs.)

With a strainer extending a thin layer of settled on a template. (Place the caramel crumbs on a baking sheet, following a template)

Bake at 140°C/284°F for 4 minutes.



(a)



(b)

FIGURE 4.6 MIMETIC BANANA WITH MANGO AND NUTMEG.

METHYLCELLULOSE

GENERAL INFORMATION

FEATURES AND USE

Methylcellulose is an effective foaming agent that gels when heated, which makes it unique among the gelling and foaming agents (most of which gel upon cooling). Thanks to methylcellulose, it is possible to create foams that can withstand heat.

TERMINOLOGY

Methylcellulose.

ORIGIN

Methylcellulose is extracted from plant cellulose through chemical treatment.

NATURAL PROPERTIES

Methylcellulose is a complex carbohydrate.

FORMS

Powder.

LEGAL INFORMATION

In Europe, methylcellulose is classified as a food additive, with EU code E-461.

KEY PROPERTIES

- Properties of a hydrocolloid.
- Used as a gelling, thickening, and foaming agent.
- Can be dispersed into hot or cold liquids, is hydrated in cold water (below 4°C/39°F), and does not dissolve in oil.
- Is thermoreversible (forms or does not form gel as a function of temperature) but acts differently than other gelling agents: forms gel when heated (50–70°C/122–158°F) and liquefies when cooled (below 50°C/122°F), depending on the food.
- Texture of foam produced with methylcellulose is soft but very unstable when cold. Methylcellulose foam has a very distinctive mouth feel when heated.

HISTORICAL NOTES

Cellulose is the most abundant substance in the cell walls of plants. It was discovered in 1838, but it was not until the mid-twentieth century that the cellulose derivatives such as methylcellulose began to be used in food industry.

GENERAL APPLICATIONS

Food industry: sweets, creams, puddings, fillings, sauces, pizza toppings, croquettes, etc.

Other: pharmaceuticals products (shampoo, toothpaste), paint additives, etc.

ADDITIONAL INFORMATION

Methylcellulose is one of several texturizers derived from cellulose. Others include carboxymethyl cellulose and hydroxypropyl methylcellulose, which also have culinary uses as thickeners, foaming agents, or stabilizers.

	g/100g
Water	5
Carbohydrate soluble fiber	93.5
Protein	0
Fat	0
	mg/100g
Chloride	610
Iron	15
Sodium	390

FIGURE 4.7 NUTRITIONAL VALUE OF THE METHYLCELLULOSE USED.

There is much variety among the different methylcellulose texturizers. Some have more gelling capacity, while others are better foaming agents than gelling agents.

CHARACTERISTICS OF THE SELECTED PRODUCT

The product we chose to study has more gelling capacity than foaming ability and produces foams that are very stable when heated. This product provides a lot of versatility as both a gelling agent and a foaming agent.

BASIC FEATURES

Information provided by the manufacturer.

- Methoxyl: 29.0–31.5%
- Viscosity: 2% in water 20°C/68°F, 525–980 cps

NUTRITIONAL VALUE

Information provided by the manufacturer.
(EU version)

There are no known restrictions on methylcellulose consumption, and it is allergen-free.

If methylcellulose is consumed in excessive amounts it can act as a laxative, but such large amounts are not used in the kitchen because they produce overly dense foams.

INSTRUCTIONS FOR USE

HOW TO PREPARE METHYLCELLULOSE FOAMS

There are two different methods for preparing methylcellulose foams, described below:

Method A: Methylcellulose Foam in a Siphon

1. Add methylcellulose to the liquid that is to be foamed.
2. Mix well with a handheld electric mixer.
3. Cool the mixture in a refrigerator to below 4°C/39°F.
4. Pour the mixture into a whipping siphon.
5. Insert the nitrous oxide (N₂O) gas cartridge in the siphon (usually one charge for a 500mL siphon and two charges for a 1 liter siphon).
6. Shake siphon vigorously.
7. Place the siphon in a water bath at a controlled temperature of 50°C/122°F.
8. Apply the foam directly to the serving plate or fill desired mold.
9. Heat the foam to approximately 60°C/140°F (for it to gel) either:
 - a. in the oven at 75–80°C/167–176°F
 - b. or in the salamander broiler at 100–120°C/212–248°F (surface temperature).

Method B: Methylcellulose Foam with a Stand Mixer

1. Add methylcellulose to the liquid that is to be foamed.
2. Mix well with a handheld electric mixer.
3. Cool the mixture in a refrigerator to below 4°C/39°F.
4. Pour the mixture into a standing mixer and beat at medium speed until desired texture is obtained.
5. Place the foam on the serving plate or fill mold.

6. Heat the foam to approximately 50°C/122°F (for it to gel) either:
 - a. in the oven at 75–80°C/167–176°F.
 - b. or in the salamander broiler at 100–120°C/212–248°F (surface temperature).

WORKING WITH METHYLCELLULOSE

CONCENTRATION

The concentration of methylcellulose required as well as the characteristics of the final dish both depend on the equipment that is used to produce the foam and the specific food product.

For Method A: Methylcellulose Foam with a Siphon

When using a siphon, the standard concentration is 0.7% to 1.5% of methylcellulose to the liquid that is to be foamed. The resulting foam will have SIPHON FOAM texture when heated.

For Method B: Methylcellulose Foam with a Stand Mixer

When using a standing mixer, the standard concentration is 0.3% to 0.7% methylcellulose. The resulting foam will have MERINGUE texture when heated.

The wide concentration range in both cases is because some products have natural foaming power (e.g., beets and licorice), and in these cases only a minimum amount of methylcellulose is necessary.

The minimum amount of liquid depends on the type of equipment used to produce the foam.

For Method A: Methylcellulose Foam with a Siphon

This amount of liquid required is equal to half the volume of the container. A standard siphon should be filled at least to the halfway point and no more than 3/4 full, so a ½ liter capacity siphon requires a minimum volume of 250 ml of liquid.

For Method B: Methylcellulose**Foam with a Stand Mixer**

For a standard capacity countertop mixer (home kitchen size), a minimum of 300 g of liquid is required for the foam to form correctly. For larger capacity professional mixers, the minimum amount of liquid necessary should be calculated based on container capacity and mixing power.

TEMPERATURE**For Method A: Methylcellulose Foam with
a Siphon and for Method B: Methylcellulose****Foam with a Stand Mixer**

Adding the methylcellulose to a hot liquid allows for better dispersion, but the hydration must occur at cold temperatures. If the methylcellulose solution does not cool down to the minimum temperature of 4°C/39°F, hydration will not be complete and the foam will not be able to form properly. When hydration is not complete, any foam that is subsequently produced will not gel properly for service.

Recommendation: Bring the temperature of the solution to 4°C/39°F quickly by placing it in a freezer or using flash freeze equipment to ensure that it reaches the appropriate temperature, and consequently the methylcellulose reaches total hydration more rapidly.

DISPERSION/HYDRATION**For Method A: Methylcellulose Foam with
a Siphon and for Method B: Methylcellulose
Foam with a Stand Mixer:**

Temperature is one of the most important factors for proper dispersion and hydration. The best technique is to use the handheld electric mixer for the dispersion and then to lower the temperature to 4°C/39°F for complete hydration. Then the solution can either be added to the siphon or placed in the standing mixer.

Useful Tip: If the food product is not heat sensitive it is better to heat the liquid before adding the methylcellulose. In this case, the handheld electric mixer is not necessary for a good dispersion, and a hand whisk can be used instead.

For Method B: Methylcellulose

Foam with a Stand Mixer

Methylcellulose foams are not susceptible to overbeating. Methylcellulose foam can be whipped without risk of breaking, so there is no concern about processing times.

Useful Tip: If needed, the mixing process can be interrupted and then restarted without breaking the foam.

ABOUT OBTAINED FOAM

FOR METHOD A: METHYLCELLULOSE

FOAM WITH A SIPHON

Methylcellulose foam is not stable over time and begins to lose its structure immediately unless it is heated and gelled. Once heated, the foam will last for several minutes until it cools down again and loses its structure. Methylcellulose foams are for immediate consumption and should be prepared just before serving.

If the foam does not obtain the desired texture, adding more methylcellulose will not help. It is almost impossible to remove all the air from the foam in order to be able to incorporate more methylcellulose into the solution.

Useful Tip: If the siphon does not produce foam, load another cartridge of gas, let it rest for a few minutes, and then try again.

FOR METHOD B: METHYLCELLULOSE

FOAM WITH A STAND MIXER

The foam produced in a standing mixer is also very unstable if not immediately subjected to heat, just like siphon foam. But with a standing

mixer, if the foam loses structure it can form again with further mixing. The mixer can even stay running throughout the meal service because unlike foams produced with egg whites or gelatin, methylcellulose foams will not break with excessive mixing. Continuous mixing can therefore preserve the optimum texture of the foam until it is warmed and served.

Like foams produced with a siphon, standing mixer foams should be prepared during meal service and heated just before being plated. After heating, the foam will last for just a few minutes under optimal conditions, until it cools and loses its structure.

The foam can be maintained for long periods at 50°/122°F (e.g., in an oven or dough proofer), provided that the surface does not dry out too much.

Useful Tip: The foam can be dehydrated to a dry texture similar to French meringue.

Caution: With both methods, adding more foaming agent will not increase the stability of the foam, as the food product itself can destabilize the foam (see section on behavior of methylcellulose with food).

BEHAVIOR OF METHYLCELLULOSE WITH DIFFERENT FOODS

Results vary depending on the characteristics of the food product and on the concentration of gelatin used. It is important that the food product has high water content, as the water is necessary for the dispersion of the methylcellulose. Liquids with high pulp content may be too heavy for optimal air incorporation.

For Method A: Methylcellulose Foam with a Siphon and for Method B: Methylcellulose Foam with a Stand Mixer:

- Foods with high salt content can affect the stability of methylcellulose foams, but increasing the concentration of methylcellulose can improve results.
- Beverages with high alcohol content do not produce stable foams.

- Foams can be produced in high acidic ($\text{pH} < 2$), but the bubbles obtained are weaker and foam has less stability.
- Liquids with high fat contents can lose foaming capacity.

We observed the behavior of methylcellulose with a variety of food products. Methylcellulose was able to produce foam in almost all cases (see Annex 3).

HANDLING AND MANIPULATION OF METHYLCELLULOSE FOAMS

SERVICE

**For Method A: Methylcellulose Foam with a Siphon and
for Method B: Methylcellulose Foam with a Stand Mixer**

Methylcellulose foams are stable when heated, but at temperatures below $50^{\circ}\text{C}/122^{\circ}\text{F}$, they become unstable and undergo syneresis. The same process can be observed at temperatures higher than $65^{\circ}\text{C}/149^{\circ}\text{F}$. Methylcellulose foams gel when heated and become stable, but at very high temperatures the gelled foam can break.

Methylcellulose foams can be heated in the oven or in a salamander broiler until the core temperature reaches $60^{\circ}\text{C}/140^{\circ}\text{F}$. The heat causes the foam to gel. When the foam is hot, it can be cut into pieces without losing its shape. In some cases, when working with a large volume of foam, the foam can be heated in the microwave for several seconds to ensure that the center of the foam gels completely. This process should be done with care, since the action of the microwave is difficult to control and if the foam is overheated it will lose its structure.

Caution: Methylcellulose foams are stable at temperatures between $50^{\circ}\text{C}/122^{\circ}\text{F}$ and $65^{\circ}\text{C}/149^{\circ}\text{F}$, so the temperature at which they are served must be carefully controlled. The foam as well as the tools and plates used must be kept within this temperature range until ready to be served.

Useful Tip: We recommend serving methylcellulose foam on heated serving dishes with heated utensils to prolong the stability of the foam.

STORAGE**For Method A: Methylcellulose Foam with a Siphon and for Method B: Methylcellulose Foam with a Stand Mixer**

Methylcellulose foams cannot be stored beyond the time of service. As the foam cools, it begins to melt and deconstruct. The best storage method is to keep the methylcellulose solution in the refrigerator until ready to prepare the foam.

Useful Tip: It is possible to dehydrate foams by heating at 50°/122°F until dry texture similar to a French meringue is obtained. Dehydrated foams have a much longer shelf life in appropriate conditions (in a closed container in a cool area free of moisture).

Caution: Dehydrated foam is very sensitive to moisture and traps any water molecules available in the atmosphere, resulting in a loss of the dry texture.

Useful Tip: When working at room temperature or in cold temperatures, gelatin can be added to the foam mixture for better stability. The gelling effect of the gelatin will disappear when the foam is heated in the oven or on the stove.

Once methylcellulose is dispersed into a liquid the resulting solution can be frozen. Freezing does not affect subsequent foam production. Once the solution is thawed the foam can be produced normally. We do not recommended freezing the foam after it has formed, however, as the cold temperatures will cause the foam to lose its structure.

SYNERGISTIC EFFECTS WITH OTHER FOAMING AGENTS

Methylcellulose can be combined with gelatin to improve foaming capacity and to increase stability of resulting foam.

**COULANT/SOUFFLÉ OF GRANADILLA WITH
CARDAMOM TOFFEE (CATALOG NUMBER 1186)**

FERRAN ADRIA, RESTAURANT ELBULLI (ROSES, GIRONA)

SWEET GRANADILLA JUICE

Ingredient

15 sweet granadillas (100 g each)

Preparation

Cut the granadillas in half and scoop out the flesh with a teaspoon over a chinois (or fine mesh strainer) to catch and strain the juice.

Process the flesh and seeds with an immersion blender on the lowest speed so that they release their juice without being crushed.

Strain the juice through a Superbag and refrigerate.

Note: The sweet granadilla (*Passiflora ligularis*) is related to the passion fruit and is native to tropical areas of South and Central America. It is a round, orange fruit with black spots and juicy seeds.

CHILLED CARDAMOM TOFFEE FOAM

Ingredients

175 g cream (35% fat)

150 g sugar

2 g cardamom seeds

1 (0.5 liter) ISI siphon

1 N₂O cartridge

Preparation

Powder the cardamom seeds in a grinder.

Melt sugar in a small pan until it turns dark caramel.

Heat the cream, add to the caramel and stir continuously to create a smooth, even mixture.

Add the powdered cardamom and leave to infuse for 30 minutes.

Strain mixture and chill the toffee in the refrigerator for 12 hours.

Fill the siphon with the toffee.

Close siphon and insert the gas cartridge.

Refrigerate.

GRANADILLA JUICE METHYLCELLULOSE CLOUD

Ingredients

250 g granadilla juice (previously prepared)

3 g methylcellulose

3 (2 g each) leaf gelatin sheets (rehydrated in cold water)

Preparation

Blend the methylcellulose into 200 g. of the granadilla juice with an immersion blender until mixture is lump-free.

Place the mixture in the freezer to quickly reduce the temperature to 3°C/37°F.

Drain the rehydrated gelatin and add it to 50 g of the granadilla juice. Heat gently until gelatin dissolves.

Once the granadilla and methylcellulose solution has reached 3°C/37°F, remove mixture from the freezer and place it in a warm place until the temperature increases to 14°C/57°F.

Put the methylcellulose solution into the mixer and beat at medium speed.

Heat the granadilla juice and gelatin mixture to 39°C/102°F. Once the methylcellulose mixture starts to foam, add the heated granadilla juice to the mixer.

Beat for about 7 minutes until the mixture forms stiff peaks like beaten egg whites.

TOFFEE AND GRANADILLA COULANT/SOUFFLÉ

Ingredients

Granadilla juice methylcellulose cloud (previously prepared)

Chilled cardamom toffee foam (previously prepared)

4 x 4.5 cm round molds, 6 cm deep and lined with parchment paper

Preparation

Put the methylcellulose cloud into a piping bag with a N° 8 tip.

Place the molds on a flat tray lined with parchment paper.

Pipe the methylcellulose cloud into the base of the each mold to form a 1 cm layer. Continue to pipe the cloud around the walls of the mold, leaving a 1.5 cm diameter space in the middle.

Freeze for 5 minutes until the cloud sets. Fill the spaces with the toffee foam.

Finish by covering the molds with a 1 cm layer of methylcellulose cloud.

Place molds in the freezer to set for 5 minutes

CARDAMOM POWDER

Ingredient

20 g cardamom pods

Preparation

Break open the cardamom pods and take out the seeds.

Use a grinder to process the seeds into a powder.

EXTRAS

Ingredient

1 (50 g) passion fruit

Preparation

Cut the passion fruit in half.

FINISHING AND PRESENTATION

Lift the soufflé with a spatula and place it in the middle of a 21 cm dish.

Carefully remove the molds without breaking the soufflé.

Heat the soufflé under the salamander broiler until hot on the outside. The inside should be almost liquid.

Sprinkle powdered cardamom over the surface of the soufflé.

Serve the halved passion fruit open and separately so that the waiter can spoon out the passion fruit seeds around the soufflé in front of the diner.

Note: As an alternative, the soufflé could be heated in a microwave at full power for 5 seconds.



(a)



(b)

FIGURE 4.8 COULANT/SOUFFLÉ OF GRANADILLA WITH CARDAMOM TOFFEE
(CATALOG NUMBER 1186) (*Continued*)



(c)

FIGURE 4.8 (Continued) COULANT/SOUFFLÉ OF GRANADILLA WITH CARDAMOM TOFFEE
(CATALOG NUMBER 1186)

LECITHIN

GENERAL INFORMATION

FEATURES AND USE

Lecithin has excellent foaming capability and produces the lightest foams (described as froth or airs) of all the foaming agents. Airls are used to add flavor to a dish without adding texture. They are simple to prepare and very popular in culinary use.

TERMINOLOGY

Soy lecithin.

ORIGIN

Lecithin can be extracted from egg yolks, sunflower oil, and soybean oil. The lecithin discussed in this chapter is from soybean oil.

NATURAL PROPERTIES

It is a natural additive group of phospholipids.

FORMS

Powder, granular, or liquid.

LEGAL INFORMATION

Lecithin is considered as an additive in Europe, with EU Code E-322.

KEY PROPERTIES

- Used as emulsifier (foaming agent) and antioxidant
- Disperses in water and soluble in oil
- Useful in the prevention of arteriosclerosis, and is thought to temper the effects of menopause
- Leaves a residual flavor in the foam, except when the food has a strong flavor that can mask the aftertaste
- Foams disappear immediately in the mouth, with almost no sensation of texture so these foams are categorized as aromas

HISTORICAL NOTES

Lecithin was first isolated from egg yolks at the end of the nineteenth century by the French scientist Maurice Goble, who named it *léchithine* (after the Greek word *lekithos* for egg yolk).

At the time, eggs were the primary source of commercially produced lecithin, which was used in a wide range of food and industrial applications. Nowadays, most of the lecithin used in food applications is primarily from soy but also from sunflower.

GENERAL APPLICATIONS

Food industry: In animal or vegetable oils and fat: chocolates, milk and other dairy derivatives, breads and pastries

Other: Pharmaceutical and cosmetic applications; also used in paints, textiles, lubricants, and waxes

ADDITIONAL INFORMATION

A wide variety of lecithins are commercially available. Take special care when choosing which product to use, as they do not all work the same way. As the granulometry increases, the foaming function decreases, so the concentration used should be formulated accordingly.

CHARACTERISTICS OF THE SELECTED PRODUCT

We chose to work with a product that is in powder form because it is easier to incorporate into solution and leaves less residual taste in the final product.

BASIC FEATURES

Information provided by the manufacturer.

- Particle size: at least 90% of particles < 315 microns
- Maximum water content: 1.5%
- pH (1% aqueous solution): 6–7

NUTRITIONAL VALUE

Information provided by the manufacturer.
(EU version)

Energy kcal/100g	900
	g/100g
Protein	0
Carbohydrate	8
Fat total	91
Saturated	12
Mono unsaturated	4
Poly unsaturated	34
Trans fats	0.1
	mg/100g
Sodium	40
Calcium	150
Vitamina E	50

FIGURE 4.9 NUTRITIONAL VALUE OF THE LECITHIN USED.

There are no known limits on culinary use and consumption of lecithin. Lecithin should be avoided by anyone who is allergic to soy (as most lecithin is obtained from soy).

INSTRUCTIONS FOR USE

HOW TO PREPARE LECITHIN AIRS (FOAM)

1. Place the liquid to be foamed in a wide, deep bowl and add the lecithin.
2. Mix well with a handheld electric mixer.
3. Apply the mixer to the surface of the liquid while tilting the mixer slightly toward the edge of the bowl. Only half of the blades should be submerged in the liquid. Most of the air incorporation should form at the surface of the solution.
4. Wait approximately 10 seconds for the air to stabilize.
5. Use a spoon to collect the foam from the surface without taking any liquid.
6. Repeat process as necessary.

WORKING WITH LECITHIN

CONCENTRATION

The standard concentration for culinary use is 0.3% to 2% lecithin to liquid to be foamed. Texture: AIRS.

Useful Tip: More lecithin can be added during processing to increase the amount of foam produced. Each time the foam is removed from the surface, part of the lecithin is removed as well so sometimes the lecithin needs to be replenished.

Any limitation on the amount of liquid depends on the equipment used to prepare the foam.

A minimum volume of liquid is necessary. With small amounts of liquid, the mechanical agitation step becomes difficult, producing insufficient amounts of unstable foam.

For example, a minimum of 300 g of liquid is recommended for home use with a handheld mixer in order to produce suitable foam. For restaurant use, where large amounts of foam are often required, we recommend working with a minimum of 2 liters of liquid.

TEMPERATURE

The preparation of lecithin airs does not require precise temperatures. Lecithin can be used with both hot and cold liquids without losing its foaming capacity.

Recommendation: When the food product contains a high proportion of fat, foam production occurs much more efficiently in hot liquids.

Useful Tip: If you want to produce lecithin foam in oil, the lecithin should be heated with the oil prior to the incorporation of air with the handheld electric mixer.

DISPERSION/HYDRATION

The dispersion of lecithin into the liquid is performed with the handheld electric mixer. Lecithin does not require a period of time for hydration and can be used immediately.

ABOUT THE OBTAINED FOAM

During meal service, foam can be produced continuously without difficulty. However, if the foam is removed from the surface multiple times, the lecithin can lose its foaming ability. When this occurs more lecithin should be added to the solution.

Caution: When collecting the foam from the surface, it is very important to avoid collecting any liquid, which would be undesirable in the finished dish.

BEHAVIOR OF GELATIN WITH DIFFERENT FOODS

Results vary depending on the characteristics of the food product and on the concentration of gelatin used. For example:

- Large bubbles form in salt rich solutions, generating a larger volume of foam. The foam is less stable, however.
- Heating solutions that are high in fat improves foam formation.
- Alcoholic beverages can inhibit foam, so we recommend diluting high proof alcoholic liquids with water in order to produce more foam.
- Cold oil is difficult to aerate, but if the oil is heated to about 55–60°C/122–140°F it is possible to produce air, though the foam will not be stable for long.
- Foods that have a high viscosity can be difficult to aerate.

We observed the behavior of lecithin with a variety of food products. Lecithin was able to produce foam (airs) in almost all cases (see Annex 3).

HANDLING AND MANIPULATION OF LECITHIN FOAMS (AIRS)

SERVICE

Lecithin foams are stable for a short period of time. Adding more lecithin does not increase the stability of the foam when plated.

Caution: High concentrations of lecithin can produce an unpleasant aftertaste.

Once lecithin foams are made, they are not stable at high temperatures (50°C/122°F) and rapidly lose their structure.

STORAGE

Lecithin airs are very light and must be consumed immediately. They cannot be stored at room temperature or refrigerated. But they are very fast and easy to prepare so they are especially suitable for rapid service. The lecithin solution can be refrigerated until ready to use. The foam should be produced with the electric mixer just before serving.

Lecithin airs can be used in frozen preparations, preferably with the use of a blast chiller. Once lecithin foams are frozen they must be served frozen. Frozen lecithin foams lose their structure when thawed.

Useful Tip: High-fat foods (chocolate, buttermilk) are best for making frozen airs.

SYNERGISTIC EFFECTS WITH OTHER FOAMING AGENTS

Lecithin is used with monodiglyceride to stabilize emulsions.

LIGHTLY MARINATED OYSTERS WITH SEA AIRS

NANDO JUBANY, RESTAURANT CAN JUBANY (CALLDETENES, BARCELONA)

SERVES 4

OYSTERS

Ingredients

24 oysters

1/2 carrot

1/2 leek

1/4 celery stalk
1/2 onion
Olive oil as needed
1 dried hot chili pepper
1 bay leaf
1 clove garlic, sliced
10 peppercorns
80 ml sherry vinegar
Seaweed as needed

Preparation

Prepare a bowl with water, ice, and salt. Open the oysters carefully so as not to break them and place them in the salted ice water. Set aside until ready to use.

Remove the oysters from the water (reserve water) and carefully remove the black “beard” from the body of each oyster. Place oysters on in a shallow pan.

Cut the vegetables into small cubes. Blanch vegetables in boiling salted water, then immediately plunge them into salted ice water to cool. Drain vegetables and spread them out over the oysters. Add a small piece of seaweed to each oyster.

Place olive oil, sliced garlic, chili pepper, bay leaf and peppercorns in a frying pan. Sauté over medium heat until the garlic is browned. Remove from heat and very carefully add sherry vinegar. Strain mixture directly over the oysters to pickle them.

SEA AIRS

Ingredients

300 ml oyster water
1.5 g soy lecithin

Preparation

Place 300 ml of the reserved oyster water in a saucepan with the lecithin. Heat mixture carefully, ensuring that it does not exceed 40°C (because lecithin will not work properly at higher temperatures).

Use an immersion blender to whip the mixture until foam forms on the surface. The best method is to blend it twice so that the foam produced will have smaller, denser bubbles.

Note: it is very important to avoid using too much lecithin to avoid leaving a bad aftertaste. The lecithin must also dissolve completely into the water for best results.

MARINADE**Ingredients**

225 g sliced carrots
450 g julienne onions
65 g crushed garlic
310 g olive oil
310 g sunflower oil
12 g black peppercorns
1 g bay leaf
4 g thyme
3 g rosemary
185 g dry white wine
185 g Forum Chardonnay vinegar
1 L chicken broth

6 g emulsifier paste per liter

3 g xanthan gum per liter

Preparation

Cut vegetables into mirepoix.

Heat the oil in a heavy saucepan and cook vegetables and garlic over low heat for 2 hours. Add the vinegar and wine and boil until the alcohol aromas disappear.

Add the aromatics (bay leaf, thyme, rosemary, black pepper) and the chicken broth and gently boil for 2 hours.

Strain the mixture and mash the vegetables in a conical strainer.

Measure the resulting quantity of liquid and add the emulsifier paste and the xanthan gum in the correct concentrations.

Use a handheld electric mixer to texturize the mixture. Add salt, pepper, and vinegar to taste.

Note: if the marinade breaks apart, blend it again until it emulsifies, trying not to exceed 60°.

ASSEMBLY

Place a spoonful of the marinade emulsion onto the plate, keeping the temperature below 60°C degrees to prevent the emulsion from breaking apart.

Arrange 5 oysters in a fan shape along the top of the plate, and place a sixth oyster in the center. Sprinkle a few drops of lemon juice over the oysters.

Bake oysters the oven to temper them.

Place the lecithin airs on top of the oysters and finish by adding a bit of green onion.



FIGURE 4.10 LIGHTLY MARINATED OYSTERS WITH SEA AIRS.

SUCROSE ESTERS

GENERAL INFORMATION

FEATURES AND USE

Like lecithin, sucrose esters produce very light foams described as airs or froths for their delicate texture. Unlike lecithin, sucrose esters are ideal for creating airs with liquids that contain a high content of alcohol.

TERMINOLOGY

Sucrose esters, also sucrose esters of fatty acids.

ORIGIN

Sucrose esters are synthesized from sugar and fatty acids.

NATURAL PROPERTIES

Product derived from sucrose.

FORM

Powder.

LEGAL INFORMATION

Sucrose esters are classified as additives in Europe, with EU code E-473.

KEY PROPERTIES

- Used as foaming agent, emulsifier, and stabilizer
- Disperses into aqueous medium; does not dissolve in oil
- Leaves no apparent residual taste in the foam. Only very small amounts of sucrose esters are needed to produce foam, so there are no discernible residual flavors
- Foams disappear immediately in the mouth, with almost no sensation of texture so these foams are categorized as aromas

HISTORICAL NOTES

Sucrose esters were first approved as a food additive in Japan in 1959. Later sucrose esters were approved for use in other countries and by FAO/WHO, and are widely used in the food industry today.

GENERAL APPLICATIONS

Food industry: margarine, ice cream, chocolates, bread (to preserve texture), cream, coffee, etc.

Other: face creams, shampoos, and as biodegradable detergents

ADDITIONAL INFORMATION

One disadvantage of sucrose esters is that they are more expensive than other emulsifiers. Sucrose esters are rarely used in the United States and Europe because of their cost but are frequently used in Japan.

CHARACTERISTICS OF THE SELECTED PRODUCT

BASIC FEATURES

Information provided by the manufacturer.

- Assay (mono-, di-, and tri-esters) not less than 80%
- Free sugars: no more than 4.0%
- Water content: no more than 4.0%

NUTRITIONAL VALUE

Information provided by the manufacturer.
(EU version)

No known restrictions on the consumption of sucrose esters for the amounts used in culinary preparations.

Energy kcal/100g	652
	g/100g
Protein (minimum)	0
Carbohydrates	47.2
Fat	51.5
Saturated fatty acid	51.5

FIGURE 4.11 NUTRITIONAL VALUE OF THE SUCRO ESTERS USED.

INSTRUCTIONS FOR USE

HOW TO PREPARE FOAMS USING SUCROSE ESTERS

1. Place the liquid to be foamed in a wide, deep bowl and add the sucrose esters.
2. Mix well with a handheld electric mixer.
3. Apply the mixer to the surface of the liquid while tilting the mixer slightly towards the edge of the bowl. Only half of the blades should be submerged in the liquid. Most of the air incorporation should form at the surface of the solution.
4. Wait approximately 10 seconds for the air to stabilize.
5. Use a spoon to collect the foam from the surface without taking any liquid.
6. Repeat process as needed.

WORKING WITH SUCROSE ESTERS

CONCENTRATION

The standard concentration for culinary use is 0.01% to 0.1% sucrose esters to liquid to be foamed.

The foam obtained is classified as froth or airs. Texture: AIRS.

Useful Tip: More sucrose esters can be added during processing to increase the amount of foam produced. Each time the foam is removed from the surface, some of the sucrose esters are removed as well; therefore, they sometimes need to be replenished.

The limitation on the amount of liquid depends on the equipment used to prepare the foam.

A minimum volume of liquid is necessary. With small amounts of liquid, the mechanical agitation step becomes difficult, producing insufficient amounts of unstable foam.

For example, a minimum of 300 g of liquid is recommended for home use with a handheld mixer in order to produce suitable foam. For restaurant use, where large amounts of foam are often required, we recommend working with a minimum of 2 liters of liquid.

TEMPERATURE

The preparation of foams with sucrose esters does not require precise temperatures. Sucrose esters can be added to hot liquids without losing its foaming capacity.

DISPERSION/HYDRATION

A handheld electric mixer is sufficient for dispersing sucrose esters into the liquid to be foamed. Sucrose esters do not require a period of time for hydration and can be used immediately.

Caution: It is possible to observe a residue in the liquid as a result of a partial dispersion into cold liquids. This does not affect the foaming process, however, and may actually disappear with stirring.

ABOUT THE OBTAINED FOAM

During meal service, foam can be produced continuously without difficulty. However, if the foam is removed from the surface multiple times, the sucrose esters can lose their foaming ability. When this occurs more sucrose esters should be added to the solution.

Also if agitating solution is not producing the desired effect, more sucrose esters can be added without dispersing them in any special way.

Caution: When collecting the foam from the surface, it is very important to avoid collecting any liquid, which would be undesirable in the finished dish.

BEHAVIOR OF GELATIN WITH DIFFERENT FOODS

Results vary depending on the characteristics of the food product and on the concentration of sucrose esters used. For example:

- Foods that have a high viscosity can be difficult to aerate.
- Sucrose esters will not produce foam with oil.

- Sucrose esters can produce foams in alcohol beverages. The foams are not affected by alcohol content, and sucrose esters can even produce foam with very high proof alcohol (40°).
- When working with dairy products, heating the solution facilitates the formation of the foam.
- Solutions with high salt contents can be aerated using sucrose esters without difficulty.

We observed the behavior of sucrose esters with a variety of food products. Sucrose esters were able to produce foam (airs) in almost all cases (see Annex 3).

HANDLING AND MANIPULATION OF SUCROSE ESTERS FOAM

SERVICE

Foams made with sucrose esters are stable for a short period of time, similar to lecithin foams. Adding more sucrose esters does not increase the stability of the foam when plated.

Once sucrose ester foams are made, they are not stable at high temperatures (50°C/122°F) and will rapidly lose structure.

STORAGE

It is possible to store the sucrose ester solution in the refrigerator and use it the following day to produce foam.

Sucrose ester foams are stable enough to be used in frozen with rapid freezing equipment, but they lose their structure once they thaw. In other words, freezing and thawing destroys sucrose ester foams.

SYNERGISTIC EFFECTS WITH OTHER FOAMING AGENTS

Sucrose esters are used in combination with monodiglyceride to stabilize emulsions.

MARINE KING PRAWNS

PACO PEREZ, RESTAURANT MIRAMAR (LLANÇÀ, GIRONA)

KING PRAWNS**Ingredient**

280 g large “Cap de Creus” king prawns

Preparation

Peel the shrimp (leave tails and heads intact) and pierce with a skewer stick.

Dip the heads in 90°C water, and then put the whole shrimp in for 8 or 10 seconds more.

Cool shrimp in a pasteurized sea water ice bath.

Cut shrimp into pieces.

SALT AIR**Ingredients**

17 g lemon

5 g kaffir lime leaf

0.2 g yuzu peel

10 g dried kombu seaweed

10 g sucrose esters

760 g pasteurized seawater

Preparation

Lightly sauté the citrus peel to release the aromas.

Place everything in a vacuum bag and infuse in Roner (sous vide) for 1 hour at 70°C.

Cool bag in ice water bath.

Strain the infused mixture, then add the sucrose esters and mix with an immersion blender.

Bring mixture to 90°C and then cool mixture.

When ready to use, whip with the blender until the airs (foam) have desired volume.

SHRIMP GEL**Ingredients**

100 g large “Cap de Creus” king prawns

200 ml mineral water

1 g Halen Môn salt

0.4 g xanthan gum

Preparation

Brown the shrimp carefully. Then add the water and salt.

Boil for 20 seconds, remove from heat, and let it infuse 2 hours.

Strain mixture. Add xanthan gum (mixing well with the immersion blender).

Strain again, and remove any air bubbles with a vacuum machine.

MISCELLANEOUS**Ingredients**

Tender sprouts

5 g salty fingers (edible leaf)

5 g Salicornia (sea beans)

10 g ice plant

Preparation

Wash and dry the assorted leaves and shoots and set aside.

SERVING

Place a small amount of the shrimp gel on the plate.

Cover the gel with the king prawn foam (airs), and put one shrimp in the middle.

Arrange the tender shoots on the sides of the plate.



FIGURE 4.12 MARINE KING PRAWNS.



CHAPTER 5

Emulsifying Agents



GENERAL PROPERTIES OF EMULSIFYING AGENTS

WHAT IS AN EMULSION?

An emulsion is a colloidal dispersion of two immiscible liquids, such as oil and water. There are two types of emulsions, according to the distribution of the water and oil droplets:

- Oil-in-water emulsions (O/W): Water is the dispersion medium, and the oil droplets are the dispersed phase. Example: mayonnaise.
- Water-in-oil emulsions (W/O): Oil is the dispersion medium, and the water droplets are dispersed in the oil. Example: butter.

This system is unstable and requires an emulsifier to stabilize the medium.

HOW DOES AN EMULSIFYING AGENT WORK?

Emulsifiers lower the interfacial tension or facilitate the formation and stabilization of the droplets, allowing the two immiscible liquids to mix correctly.

This works because emulsifiers are amphiphile: one part of their structure has an affinity for aqueous mediums (the hydrophilic part), and another part has an affinity for fats (the lipophilic part).

The criteria for choosing emulsifiers for kitchen use are different from those used in the food industry, but the products are basically the same. For kitchen use, preserving the organoleptic properties of the food is most important criterion, and technological functionality is the second consideration. In other words, a cook will choose an unstable emulsion with optimal flavor over an emulsifier that ensures stability but leaves an aftertaste. Obviously flavor is very important for the food industry, but other factors such as storage and transportation also influence the choice of techniques and products to use. Home cooks and restaurant chefs have the luxury of being able to experiment more freely, as they will serve their prepared food more or less immediately and are therefore able to explore new culinary uses for emulsifiers.

Agitation is the basic technique used to form a stable emulsion. The emulsifier must be shaken vigorously between the two immiscible media, creating droplets of the two different mediums so that it can locate itself between the two layers and stabilize the system.

When the emulsifier is not performing well, the medium becomes disorganized and the two phases will separate over time.

PRINCIPAL CHARACTERISTICS OF EMULSIFYING AGENTS

A wide variety of emulsifying agents are commercially available, each with distinct properties that cause them to react differently with various mediums and produce varied final textures.

Emulsifiers	Mono Diglycerides	Textures*												Elaborations**						General Concept				
		Sauce	Emulsified Sauce	Nectar	Liquid Cream	Thick Cream	Puree	Texture Flan	Gelee	Nappage	Air	Soft Meringue	Hard Meringue	Marmalade	Aspic	Thin Layers to Wrap	Jelly Bean	Mousse	Espuma	Ice Cream & Sherbet	Suspension Effect	Sferification Technique*	Cold Elaboration	Warm Elaboration
	x		x		✓	✓	x	x	x	x	x	x	x	x	x	x	x	✓	✓	x	x		✓	x

✓✓	It is very appropriate.
✓	It can be used.
*	Not applicable

FIGURE 5.1 PRINCIPAL CHARACTERISTICS OF MAIN EMULSIFIERS USED IN COOKING.

Figure 5.1 classifies the most common emulsifiers used in cooking and their principal characteristics.

PROPERTIES OF EMULSIFYING AGENTS

Success with food emulsions depends mainly on choosing the right emulsifying agent for the job. Not all emulsifier all work the same—some dissolve in oil or other fat, and others dissolve in water or aqueous material. The following sections outline some of the textures that can be created with an emulsion and how they are classified for cooking purposes.

EMULSION FIRMNESS

The degree of firmness of an emulsion can be described with the following terms:

- Liquid (e.g., vinaigrette)
- Thick (e.g., mousse)
- Hard (e.g., mayonnaise)

The texture of an emulsion depends on the type of emulsifier used and depends even more on the concentration used. Increasing the concentration of the emulsifying agent will produce a firmer texture, and decreasing it will result in a softer more fluid texture. Varying the ratio of water and oil can also affect the properties of the resulting emulsion.

ABOUT EMULSIFIERS

This chapter describes some of the emulsifiers that are the most widely used for cooking. We will address their different properties to provide a better understanding of them and to facilitate their use.

Please read the entire section because you will find answers to some of the most common questions about these products, questions that may arise as you start to work with them. For each product, we describe the following characteristics.

DESCRIPTION OF HOW THE PRODUCT IS USED AS AN EMULSIFIER

In this section we give an overview of the emulsifying agent and its main characteristics such as origin, any allergic content, description of the texture it produces, and the resulting mouthfeel.

INSTRUCTIONS FOR USE

- Information about the preparation of the emulsifying agent for obtaining the desired emulsion. This section provides information on how to obtain an emulsion by providing the use specifications for each of the products. The necessary steps and proportions are explained as well as proper handling and best practices for achieving optimal results:
 - Guidance on the minimum and maximum amounts of emulsifying agent required for different preparations and the equipment used to obtain them

- Description of which type of emulsion results from different concentrations of emulsifier can be achieved
 - The minimum quantity of the immiscible mediums to be emulsified necessary to avoid separation of the phases
 - The correct proportion of water to oil for obtaining a good emulsion
 - Required temperatures for each preparation step, and the description in case very precise temperatures are needed
 - Mixing method required for a good dispersion: strong, medium, or no agitation
 - Mixing time required to obtain desired texture for the emulsion and the order in which the ingredients should be added
 - Suggestions for how to improve emulsions.
-
- Information about the characteristics of the obtained emulsion, whether or not it can be prepared with any food, and what can be done to improve the outcome if the texture does not meet expectations
 - Observations about how emulsifiers work with different liquids and concentrations required according to type of liquid
 - Description of types of emulsion obtained for each concentration
-
- Information about foam preservation and storage conditions:
 - Duration of time that emulsion will retain the same or similar features Description of ideal storage conditions
 - Information about appropriate service temperatures for each of the emulsions described, best uses for each type of foam, and how long foam bubbles will last
 - Whether or not the emulsion may be frozen and thawed (maintaining the same flavor and texture characteristics)
 - Whether or not the emulsion is irreversible, or if it can be formed a second time
-
- Information about potential synergistic effects from combinations with other texturizing agents to improve results, or for other applications
 - When there are synergistic effects with other texturizing agents or emulsifiers that can be used to improve results, such as

stabilizing the emulsion, providing heat resistance, or increasing other effects

- Common synergistic combinations with other texturizing agents or emulsifiers that improve results by adding stability to the emulsion, adding heat resistance, or increasing other texture effects

Throughout the instructions for use, certain information is highlighted with the following terms:

Recommendations: usage tips.

Caution: possible risks associated with the process.

Useful Tips: featured methods and techniques.

PRINCIPAL DISHES/PREPARATIONS USING EMULSIFIERS

Figure 5.2 shows some of the possible dishes that can be prepared using emulsifying agents, taking advantage of their varied capabilities. Emulsifying ability is the main characteristic taken into consideration here.

The textures presented in the figure are a random sample of different possibilities that can be achieved with a product to provide an idea of the different possibilities to be done. These are not necessarily the only textures that can be produced nor the appropriate names for them, these are only examples and they can vary depending on many different factors.

These examples of how texturizing agents can be used provide a guideline for further experimentation. Of course, the real range of possibilities is much too great to fit into a summary figure.

MONOGLYCERIDES AND DIGLYCERIDES

GENERAL INFORMATION

FEATURES AND USE

Monoglycerides and diglycerides provide a semisolid texture and work well with W/O emulsions that have a high oil content.

TERMINOLOGY

Mono and diglycerides, also known as mono and diglycerides of fatty acids.

ORIGIN

Mono- and diglycerides are formed through a chemical reaction between a glycerol molecule with various fatty acids. The raw materials that are used to obtain the fatty acids are obtained from pork fat and

Energy kcal/100g	790
	g/100g
Protein	0
Carbohydrate	0
Fat total	≥99
Total fatty acids	≤76
Saturated	≤74
Monounsaturated	≤2
	mg/100g
Potassium	5

FIGURE 5.2 NUTRITIONAL VALUE OF THE MONOGLYCERIDES AND DIGLYCERIDES USED.

vegetable oils (sunflower, coconut, or palm oil). Mono- and diglycerides can be found in nature but are commonly manufactured through industrial processes.

NATURAL CHARACTERISTICS

Compounds derived from the reaction between glycerol and fatty acids.

FORMS

Powder, flakes, or liquid.

LEGAL INFORMATION

Mono- and diglycerides are classified as additives in Europe, and their EU code is E-471.

KEY PROPERTIES

- Used as emulsifiers.
- Ideal for use with W/O emulsions. In other words, they have a greater affinity for oil than water. This means that the emulsifier is dispersed into the oil rather than the aqueous phase.

HISTORICAL NOTES

The product has been marketed for the past 50 years, ever since the first patent was filed.

GENERAL APPLICATIONS

In the food industry: ice cream, vegetable and animal oils, quick cooking rice, cocoa and chocolate, milk and other dairy products, bread, fresh pasta, preserves, jams, jellies, fruit spreads, low-calorie products, etc.

ADDITIONAL INFORMATION

Mono- and diglycerides impart give a very strong flavor to the emulsion, particularly if used in high concentrations. At high concentrations, they can also create a waxy texture. It is important to be careful with the proportions to creating unwanted textures or flavors.

CHARACTERISTICS OF THE SELECTED PRODUCT

We chose to work with the product that is most commonly used in the food industry. This product easily creates emulsions in high fat mediums.

BASIC FEATURES

Information provided by the manufacturer.

- Aspect at 25°C: white flakes
- Acid value: max. 5
- Iodine value: max. 3
- Monoester: min. 36%
- Melting range: 54–60°C

NUTRITIONAL VALUE

Information provided by the manufacturer.
(European Community version)

There are no restrictions on the consumption of this product, and it is safe for people with dietary restrictions. Does not contain allergens.

INSTRUCTIONS FOR USE**PREPARATION OF AN EMULSION**

There are two ways to use mono- and diglycerides. They can be used as texturing agents only for oil and foods with a high fat content (e.g., to

make pralines). They are used to give oil a more solid texture, similar to butter.

The second use for mono- and diglycerides is for making emulsions with mediums that have a higher percentage of water, such as mayonnaise-type products. Often in this case, the mono- and diglycerides are not acting alone. Another emulsifier that can stabilize O/W emulsions (as opposed to the previous) is added and the two complement each other, increasing the stabilization of the emulsion.

Method A: Mono- and Diglyceride Emulsion

1. Add the mono- and diglycerides to the oil phase.
2. Mix gently.
3. Heat until dispersion is complete, to at least 60°C/140°F.
4. Pour the mixture into a container and place it in an ice water bath.
5. Slowly pour the aqueous phase into the oil phase, stirring constantly with an electric whisk.
6. Leave the mixture in the refrigerator so that the oil phase solidifies. If the emulsion is not sufficiently stable, beat mixture with a handheld electric mixture until stable.
7. Let rest in the refrigerator to firm up the texture.

Method B: Mono- and Diglycerides as Texturizing Agent for Oils

1. Add the mono and diglycerides to the oil and heat until completely dissolved (to at least 60°C/140°F).
2. Remove from heat and place in a separate container. Place the container in an ice water bath.
3. Mix well with a handheld electric mixer until a viscous texture is obtained.
4. Place in the refrigerator until mixture has a firm yet spreadable texture.

PREPARING THE EMULSIFIER

CONCENTRATION

For Method A: Emulsions with Mono- and Diglycerides

The basic concentration range for cooking purposes is between 4% and 10% by weight of mono- and diglycerides to the total mixture.

For example, for 100 g of water and 100 g of refined olive oil (0.4°) at refrigeration temperature (4°C/39°F), the following mixtures are obtained:

- Concentration of 4%: begins to stabilize the emulsion.
- Concentration between 4% and 6%: liquid texture. EMULSIFIED SAUCE
- Concentration between 7% and 8%: thick texture. THICK CREAM
- Concentration between 8% and 10%: firm texture. THICK CREAM/MAYONNAISE

The final texture of the emulsion greatly depends heavily on the food that is emulsified, the concentration of emulsifier, and the temperature reached during the process.

The ration of the two phases in the medium, the aqueous and oil phases, affects the final texture of the emulsion. Our experimentation found that the medium should contain a minimum of 50% oil for the mono- and diglycerides to create a stable emulsion. If the percentage of oil is less than 50%, the emulsion will not form.

For Method B: Texturizing Oil with Mono- and Diglycerides

The basic concentration is between 2% and 4% by weight of mono- and diglycerides. For example, when mono- and diglycerides are added to 100 g of olive oil (0.4°) at refrigeration temperature (4°C/39°F) in different concentrations, the following textures are obtained:

- Concentration of 2%: starts to give a viscous texture
- Concentration between 2% and 4%: softer texture: CREAM/LIQUID
- Concentration between 4% and 8%: hard texture: THICK CREAM/BUTTER

The resulting textures are very dependent on the concentration used and the temperature of the oil, which has a very different texture at room temperature than when it is refrigerated.

TEMPERATURES**For Method A: Emulsions with Mono- and Diglycerides and for Method B: Texturizing Oil with Mono- and Diglycerides**

The mixture of the oil medium with mono- and diglycerides requires a minimum temperature of 60°C/140°F. A thermometer is not needed if you can observe the mono- and diglycerides disperse. Once the flakes disappear, the mono- and diglycerides are integrated into the oil.

Mono- and diglycerides are not affected by heat and do not lose their ability to emulsify at high temperature. However, we do not recommend overheating the oil when mixing in the mono- and diglycerides, as the oils can undergo changes in taste and composition and can degrade more rapidly.

When forming the emulsion, no specific temperature is required for incorporating the aqueous phase into the oil containing the mono- and diglycerides. The temperature should be somewhere between cold and room temperature. If the liquid is hot, the emulsion will form, but it will end up weaker and unstable until it is cooled in the refrigerator.

DISPERSION/HYDRATION**For Method A: Emulsions with Mono- and Diglycerides and for Method B: Texturizing Oil with Mono- and Diglycerides**

Proper dispersion and hydration is very important when working with emulsifiers. It is essential to know whether emulsifier can incorporate into an aqueous medium or an oil medium.

The emulsifier that we chose for testing should be incorporated into an oil medium at a temperature of 60°C/140°F (as mentioned already).

The method for preparing the emulsion is always to add the aqueous phase to the oil phase. As more water is added, the emulsion loses stability and becomes more fluid. Although you can use a whisk for this step, we recommend using a handheld electric mixer when adding the water. The emulsion will be more stable, as the drops of water and oil emulsify better with strong agitation. Even so, there may still be problems with forming the emulsion. We recommend placing the mixing bowl in an ice water bath, as when making mayonnaise. We recommend starting with a minimum amount of 150 g total liquids to achieve a good homogenization of the two immiscible media and a stable result.

The same applies for Method B. The oil must be refrigerated or placed in an ice water bath, a handheld electric mixer is needed, and a minimum working amount of 150 g of liquids is recommended.

In conclusion, there are two important assumptions for both methods:

- Strong agitation
- Cooling the emulsion while stirring

If the emulsion does achieve the desired texture, place it in the refrigerator to chill and then try again to form the emulsion using the handheld electric mixer.

ABOUT THE OBTAINED EMULSION**FOR METHOD A: EMULSIONS WITH
MONO- AND DIGLYCERIDES**

Heat will destroy the structure of the emulsion, the two phases will separate, and it is very difficult remake the emulsion. The emulsion is therefore not reversible.

If the resulting emulsion does not have the desired texture, adding more emulsifier, more water, or more oil will not solve the problem. This type of emulsion cannot be improved once it has formed. The emulsifiers that are used for food and cooking are less potent than those used in the food industry.

When using this method, it is not possible to add more emulsifying agent if the initial concentration is not sufficient. It is important to take care in choosing the concentration needed and to weigh the ingredients carefully.

**FOR METHOD B: TEXTURIZING OIL WITH
MONO- AND DIGLYCERIDES**

With this method, there is no problem with adding more mono- and diglycerides to the mixture to improve the texture. More oil can also be added if needed. However, it is necessary to follow the instructions correctly to recover the texture of the oil, which can be reheated and then cooled as in the initial process.

Recommendation: For optimal food safety, to avoid cross-contamination and microbiological growth, we recommended covering the emulsion and storing it in the refrigerator.

**BEHAVIOR OF MONO- AND DIGLYCERIDES
WITH VARIOUS FOODS****For Method A: Emulsions with
Mono- and Diglycerides**

The formation of the emulsion depends on the characteristics of the food product used and the concentration of mono- and diglycerides used. For example:

- In an environment with high concentrations of salts such as sodium chloride and calcium chloride, the emulsion will form but will become unstable over time.
- Alcohol beverages can generally be emulsified without problems.
- When working with acid mediums ($\text{pH} < 2$), the emulsion may become unstable over time.

After studying the behavior of mono- and diglycerides, we tested them with various common foods (see Annex 4).

**For Method B: Texturizing Oil with
Mono- and Diglycerides**

This case applies only to oil. The texturizer can be added to different oils such as olive oil, corn oil, and peanut oil.

HANDLING AND MANIPULATION OF AN EMULSION**SERVICE****For Method A: Emulsions with Mono- and
Diglycerides and for Method B: Texturizing
Oil with Mono- and Diglycerides**

Emulsions with mono- and diglycerides are not stable at hot serving temperatures ($50^{\circ}\text{C}/122^{\circ}\text{F}$ and $80^{\circ}\text{C}/176^{\circ}\text{F}$). These are cold preparations and must be served cold. The moment they are heated, the two

phases separate (in the case of Method A) or the oil liquefies (in the case of the Method B).

Emulsions with mono- and diglycerides are very heat sensitive, and the phases begin to separate at 30°C/86°F.

It is important to keep the emulsion in the refrigerator for as long as possible before service.

As mentioned already, emulsions that are made with the Method A are not reversible, so once the emulsion becomes unstable it cannot easily be recovered.

With Method B, however, the texture can be restored by cooling the mixture and then reforming the emulsion.

STORAGE

For Method A: Emulsions with Mono- and Diglycerides and for Method B: Texturizing Oil with Mono- and Diglycerides

The shelf life of an emulsion prepared with Method A is linked to the shelf life of the foods with which it was prepared. This is less important with Method B. The emulsions should be covered stored in the refrigerator with a cover to prevent the absorption of other flavors or any cross contamination.

The emulsion should remain stable for several days in the refrigerator. However, it should be noted that the texture is firmer when the emulsion is very cold. As soon as the emulsion is exposed to room temperature it will begin to soften, so it's important to determine what the final texture should be at the time of service to calculate the concentration of emulsifier needed initially. The same applies to Method B.

If an emulsion made with Method A undergoes syneresis in the refrigerator, this is an indication that the emulsion is unstable and the phases are separating. The mixture should be agitated with a handheld electric

mixer to stabilize the emulsion at the time of service. In some cases the syneresis may be irreversible and the emulsion will not re-form.

Neither type of emulsion (Method A or Method B) can be frozen. Freezing breaks the structure of the emulsion—irreversibly for emulsions made with Method A. For emulsions made with Method B, the mixture can be thawed in the refrigerator. The remade emulsion will have a softer final texture, however.

SYNERGISTIC EFFECTS WITH OTHER TEXTURIZING AGENTS

FOR METHOD A: EMULSIONS WITH MONO- AND DIGLYCERIDES

Other emulsifiers such as sucrose esters or lecithins can be used to improve an emulsion. They are added to the aqueous medium and produce a more stable final preparation. For example:

- Sucrose ester: increases stability of the emulsion. Concentration: 0.01% sucrose ester and 4% mono- and diglycerides.
- Lecithin: increases stability of the emulsion. Concentration: 1% lecithin to 4% mono- and diglycerides.

For both cases, the instructions are as follows:

1. Add the mono and diglycerides to the oil phase.
2. Gently heat the mixture until dispersion is complete—a minimum of 60°C/140°F.
3. Add the sucrose ester and lecithin to the aqueous portion, which should be cold or at room temperature.
4. Pour the oil phase mixture into a container that is placed in an ice water bath, and add the aqueous phase little by little, stirring with a handheld electric mixer.
5. Place mixture in the refrigerator.

**FOR METHOD B: TEXTURIZING OIL WITH
MONO- AND DIGLYCERIDES**

No other type of texturing agent can stabilize this kind of emulsion, as it cannot be hydrated in oil.

**HOARFROST 2007 NUTS, COLD
FROSTED TREE, AND SHRIMP**

QUIQUE DACOSTA, RESTAURANT ELPOBLET (DÉNIA, ALICANTE)

ARGAN OIL AND SHRIMP**Ingredients**

60 g argan oil

100 g crayfish heads

Preparation

Sautee both sides of the crayfish heads in a pan.

Place them into a vacuum bag with the argan oil and close. Put into a Roner for 3 hours.

Keep the bag closed six hours, chilled.

SHRIMP CORAL**Ingredients**

15 shrimp heads

Mild olive oil

Salt

Preparation

Brush the shrimp heads with oil, salt them to taste, and place on the plate. Cool them quickly and squeeze the extract from the shrimp heads onto the tail of the shrimp on the dish. This will possibly heighten the flavor of the shrimp.

SEMI-CONFIT SHRIMP**Ingredients**

500 g shrimp (type: grescas the Denia)

Olive oil, 0.4% acidity

20 g ripe lemon peel

8 g garlic cloves

2 black peppercorns

Preparation

In a vacuum bag put the oil, lemon peel, garlic clove, and pepper.

Introduce into the Roner for 3 hours at 55°C/131°F.

Meanwhile, clean the shrimp (reserve heads and shells). Add the infused oil by straining it onto the tray with the shrimp. Keep cold. Sprinkle with salt just before serving.

FROST-FROZEN SHRIMP AND HERBS**Ingredients**

25g oil

5 garlic cloves

½ cayenne pepper

300 g onions

150 g carrots

200 g white leek

300 g shrimp heads or whole shrimp

1 g paprika

120 g tomatoes

150 g tomato sauce

55 g brandy (flambé)

2 L seafood broth (el poblet recipe)

1L water

4 sheets of gelatin

85 g butter

8 g sucrose ester

Preparation

Sauté the vegetables until they are cooked but not browned.

Add the shrimp heads and fry well. Add the peppers and tomatoes.

Flambé mixture with the cognac and add the liquids. Simmer for 40 min, then let stand to cool.

Blend mixture with the Thermomix at full power, then strain with a super bag.

Add the previously hydrated gelatin sheets, then add the sucrose ester and mix well.

Gradually incorporate the butter.

With the help of an aquarium pump, emulsify the mixture and then freeze the foam/emulsion.

PISTACHIO OIL FOAM**Ingredients**

600 g pistachio oil

46 g mono- and diglycerides

Siphon with 2 charges

Salt glaze

Preparation

Bring the oil to 70°C/158°F and add the mono- and diglycerides.

Dissolve well. Place mixture in a siphon with two charges and let mixture cool.

PISTACHIO FROST

Spread the pistachio oil foam on a frozen gastronom and freeze.

Left is a sponge texture achieved only with oil.

Break into small pieces.

ADDITIONAL GARNISHES

Fresh pistachios
Green fresh orchids
Dry smoked pistachios
Pistachio praline
Pistachio powder

FINISHING AND PRESENTATION

Place some pistachio oil foam on a chilled plate. Place three shrimp (seasoned with shrimp coral), three smoked pistachio nuts, 2–3 tender pistachios, some pistachio praline, and three orchid petals on the plate. Sprinkle pistachio powder over the pistachios. Top with 2 pieces of the pistachio frost. Add “smoke” and serve immediately.



FIGURE 5.3 HOARFROST 2007 NUTS, COLD FROSTED TREE AND SHRIMP.



ANNEX

		Gelatine	Agar	Sodium Alginate method A	Kappa Carrageenan	Iota Carrageenan	Elastic Gel-lan Gum	Rigid Gel-lan Gum	Pectin HM	Pectin LM	Methyl-cellulose Method A
% Food-stuff		Concentra-tion 4–12 leaves/L	Concentra-tion 0.2–1.5%	Concentra-tion 0.5–0.8%	Concentra-tion 0.2–1%	Concentra-tion 0.2–0.7%	Concentra-tion 0.2–0.8%	Concentra-tion 1–2.5%	Concentra-tion 1–3%	Concentra-tion 1–2%	Concentra-tion 0.7–1.5%
		Fruits									
		Lemon Juice	100	✓ x	x	x	x	x	✓	✓ x	✓ x
		Apple Juice Granny Smith	100	✓	✓ x	✓	✓	✓	✓	✓ x	✓
		Mango puree	50	✓	✓	✓	✓	✓	✓	✓	✓
Dairy											
		Whole Milk	100	✓	x	✓	✓	✓	x	✓	✓
		Cream 35% Fat	100	✓	x	✓	✓	✓	x	✓	✓ x
Vegetables											
		Carrot Juice	100	✓	x	✓	✓	✓	x	✓	✓
		Tomato Water	100	✓ x	✓	✓	✓	✓	x	✓ x	✓
Alcohols											
		Whisky (40°)	100	✓	✓	✓	✓	✓	✓ x	x	x

Campari (20°)	100	✓	✓	✓*	✓	✓	✓	✓	✓	✓*	✓	✓*	✓*	✓*	✓*	✓*	✓*
Red Wine (12°)	100	✓*	✓	✓*	✓*	✓	✓	✓	✓	✓*	✓	✓*	✓*	✓*	✓*	✓*	✓*
Others																	
Soy sauce	50	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Vinegar (6° Ac)	50	✓	✓*	✓*	✓*	✓*	✓*	✓*	✓*	✓*	✓*	✓*	✓*	✓*	✓*	✓*	✓*
Mint water	100	✓*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Meat stock 3% fat	100	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
✓	Form A Gel																
✗	Does Not Form A Gel																
✓*	Need High Concentration																

FIGURE A.1 ANNEX 1.

	% Food-stuff	Fruits														
		Cornstarch Concentration 2–10%	Kuzu Starch Concentration 3–6%	Xanthan Gum Concentration 0.1–0.7%	Locust Bean Gum Concentration 0.2–1%	Guar Gum Concentration 0.2–1%	Tara Gum Concentration 0.2–1%									
Lemon Juice	100	✓ ✗	✓	✓	✓ ✗	✓ ✗	✓ ✗									
Apple Juice Granny Smith	100	✓	✓	✓	✓	✓	✓									
Mango puree	50	✓ ✗	✓	✓	✓	✓	✓									
Dairy																
Whole Milk	100	✓	✓	✓	✓	✓	✓									
Cream 35% Fat	100	✓	✗	✓	✓ ✗	✓ ✗	✓ ✗									
Vegetables																
Carrot Juice	100	✓	✓	✓	✓	✓	✓									
Tomato Water	100	✓	✓	✓	✓	✓	✓									
Alcohols																
Whisky (40°)	100	✗	✗	✓ ✗	✗	✗	✗									
Campari (20°)	100	✓ ✗	✓ ✗	✓	✗	✗	✓									
Red Wine (12°)	100	✓	✓	✓	✗	✗	✗									

Others									
Soy sauce	50	✓				✓			✓
Vinegar (6° Ac)	50	✓				✓		✓ x	✓ x
Mint water	100	✓				✓		✓ x	✓ x
Meat stock 3% fat	100	✓				✓		✓	✓

✓	Form a thick texture
x	Does not form a thick texture
✓ x	Form a thick texture with defects

FIGURE A.2 ANNEX 2.

		Egg White Powder	Gelatine Method A Sifon	Gelatine Method B Stand Mixer	Methylcellulose Method A Sifon	Methylcellulose Method B Stand Mixer	Lecithin	Sucroester
% Food-stuff		Concentration 2–8%	Concentration 4–10 leaves/L	Concentration 6–10 leaves/L	Concentration 0.7–1.5%	Concentration 0.3–0.7%	Concentration 0.3–2%	Concentration 0.3–2%
Fruits								
	Lemon juice	×	✓ ×	×	✓ ×	✓ ×	✓	✓
	Apple Juice Granny Smith	✓ ×	✓	✓	✓	✓	✓	✓
	Mango puree	×	×	×	×	×	×	×
	Mango puree	×	✓	✓	✓	×	✓	×
Dairy								
	Whole Milk	×	✓	✓	✓ in warm	×	✓	✓
	Cream 35% Fat	×	✓	✓	×	✓	×	×
Vegetables								
	Carrot Juice	✓	✓	✓	✓	✓	✓	✓
	Tomato Water	✓	✓	✓	✓ ×	✓ ×	✓	✓
Alcohols								

Whisky(40°)	50	×	×	×	×	×	×	×	×	×	×	✓
Campari (20°)	50	✓	✓×	×	×	×	×	×	×	×	×	✓
Red Wine (12°)	50	✓	✓	✓	×	×	✓	×	✓	×	×	✓
Others												
Soy sauce	50	✓	×	×	×	×	✓×	×	✓×	×	✓	✓
Vinegar (6° Ac)	50	✓	✓×	×	×	×	✓×	×	✓×	×	✓	✓
Mint water	100	✓×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Meat stock 3% fat	100	×	✓	✓	✓	✓	✓in warm	×	×	✓	✓	✓
✓	Form a foam											
✓	Does not form a foam											
✓×	Form a not stable foam											

FIGURE A.3 ANNEX 3.

		Mono and Diglycerid Method A
	% Foodstuff	Concentration 4–10%
Fruits		
Lemon Juice	50	✓
Apple Juice Ganny Smith	50	✓
Mango puree	50	✓
Dairy		
Whole Milk	50	✓
Cream 35% Fat	50	✓
Vegetables		
Carrot Juice	50	✓
Tomato Water	50	✓
Alcohols		
Whisky (40°)	50	✓
Campari (20°)	50	✓
Red Wine (12°)	50	✓
Others		
Soy sauce	50	✓
Vinegar (6° Ac)	50	✓
Mint water	50	✓
Meat stock 3% fat	50	✓

✓	Form an emulsion
✗	Does not form an emulsion

FIGURE A.4 ANNEX 4.

	Details	pH	°Brix
Lemon Juice	Fresh lemon	3.12	6.2
Granny Smith Apple Juice	Fresh apple	4	12.8
Mango purée	Commercial: 88% mango, sugar, aroma and citric acid	4.27	10.8
Whole Milk	Commercial	6.44	12.6
Half Cream of 35% MG	Commercial	6.49	13.7
Carrot Juice	Fresh carrot	6.04	9
Tomato Water	Fresh tomato	4.75	5.2
Whisky	40° alcoholic	4.6	14.1
Campari	20° alcoholic	5.35	31.2
Red Wine	12° alcoholic	3.42	2.2
Soy sauce	Water, soy, wheat, salt	4.87	34.6
Vinegar 6°	6° acidity	3.5	6
Herbs water	Mint water	6.2	1.4
Meat stock 3% Fat	Homemade	7.3	28

FIGURE A.5 ANNEX 5.



GLOSSARY

Acid: Product with characteristic organoleptic properties related to a tendency to lose hydrogen ions. In gastronomic terms, the word acidic is used to describe one of the basic tastes. An acid has a pH range from 0 to 7. In culinary use, the range is from 2.5 to 7, as the most acidic citrus has a pH value of approximately 2.5.

Additive: Substance without nutritional value that is intentionally added to a product or food preparation to increase shelf life, to facilitate or improve preparation of the product, or to modify its physical or organoleptic characteristics.

Amphiphilic (or amphipathic): Describes a chemical compound possessing both hydrophilic (*water-loving*, polar) and lipophilic (*fat-loving*) properties.

Anticaking agent: A product that reduces the tendency of powdered substances to stick together over time and in humid conditions by preventing bonding between particles of the product.

Atom: Elemental component of matter. Smallest unit of a chemical element.

Bacteriostatic agent: Chemical or biological agent that limits the growth of bacteria on a surface or food.

Basic spherification: A technique created in 2003 used to control the gelling of a liquid by mixing it with sodium alginate and immersing it in a bath containing the appropriate concentration of calcium. The liquid forms spherical gels, which vary in size according to the application technique used (e.g., spoon, syringe, siphon).

Bloom (degrees): Measurement of the gel strength of a product. Bloom is measured with a device called a Bloom gelometer. Bloom is frequently used to describe the gelling strength of gelatin. Gelatin

comes in a variety of gelling strengths, ranging from about 75 to 300 Bloom. Gelatins with higher bloom numbers produce stronger gels. The standard Bloom strength for sheet gelatin is 220.

Brix (degrees): Measurement of the amount of sugar in a liquid food. Usually expressed as a percentage of grams of sugar per 100 grams of product.

Bulking agent: Additive that increases the volume or weight of a food product or preparation, also called fillers. Widely used in the food industry and to increase the volume of sweeteners.

Colloidal dispersion: The dispersion of large molecules or molecule aggregates into a (usually) aqueous solution. The molecules do not dissolve, though they may appear to be dissolved into solution. The resulting mixture tends to be considerably more viscous than water. The molecules are also known as colloids.

Cross-contamination: Occurs when bacteria are transferred from one food to another, typically by means of unclean cutting boards or countertops, knives and other kitchen utensils, or unwashed hands. Cross-contamination can lead to food poisoning.

Dipolar: A dipolar molecule has electrons that are more displaced toward one part of the molecule, yielding a negative charge and leaving the other end of the molecule positively charged. These molecules then position themselves to form positive–negative junctions with one another.

Dispersion: Distribution of the particles of one substance into the continuous phase of another more abundant substance.

Dissolution (or solution): Homogeneous mixture of two or more substances (generally liquids) that do not react with one another.

Hydrates of carbon: Biochemical compounds that provide energy or fiber to the body. Also known as carbohydrates. Composed of hydrogen, carbon, and oxygen molecule. There are two types of carbohydrates digestible (starch) and indigestible (fiber, cellulose).

Hydration: Increase in the water content of a product. The properties of gelling and thickening agents are partly due to the absorption of water by hydrocolloids.

Hydrocolloid: Protein or complex carbohydrate (polysaccharide) that has the ability to trap water molecules, causing the formation of gels or the thickening of a liquid.

Hydrophilic: Having the tendency to bind to water molecules and therefore is soluble in water. A product that does not have this tendency would be described as hydrophobic.

Humidity: The presence or amount of water (even trace amounts) in a medium. Relative humidity is the degree of humidity expressed as a percentage relative to the maximum humidity (100%) at a given temperature.

Ingredient: Any simple product (consisting of a single component) involved in the composition of a food. In culinary terms an ingredient is one of the foods or substances used to make a preparation or dish.

Ion: Atom or molecule with an electric charge (positive or negative). Positive ions are called cations and negative ions are anions.

Irreversible: Cannot return to a previous state or situation.

Lipophilic: Describes a molecule or substance that has an affinity for lipids (fats). The term for the opposite condition (aversion to lipids) is lipophobic.

Molecule: Defined grouping of atoms, joined by chemical bonds of varying stability. Molecules can have different properties than the atoms or simple molecules of which they are made.

Overrun: An increase in volume (with respect to the initial volume) that a mixture undergoes during processing. Refers to the amount of air that is incorporated during preparation.

pH: Measure of the degree of acidity of a product in aqueous solution. Stands for potential hydrogen (because it is interpreted as a measure of “free” hydrogen ions that are produced by each degree of acidity). Degree of acidity: 0–7: Acid/7: Neutral/7–14: alkali or base. For example, lemon juice has a pH of 2.5–3, water has a pH of 7, and eggs have a pH of around 8.

Reverse spherification: To overcome the difficulty of achieving basic spherification with certain calcium-rich foods, this process reverses the technique by introducing a calcium-rich food into a sodium alginate bath.

Reversible: Capable of reverting to original state or form.

Shear: A cutting force, transverse to the surface on which the force is applied, that is produced between layers of the same element.

Sodium citrate: Additive E-331, a salt formed from citric acid. Used to regulate the acidity of high acid food preparations.

Soluble: Ability of a product to be dissolved into another product. For example, sugar is soluble in water but is not soluble in olive oil.

Suspending agents: Ability of certain products (xanthan gum, iota-carrageenan, high acyl gellan gum), when dissolved in liquid medium, to prevent solids from settling out of the solution.

Stabilizers: Chemical compounds or mix of compounds that help to maintain the state of a food preparation. Most gelling and thickening agents act as stabilizers. Stabilizers can preserve the texture, color, or other features of a food product.

Sterilization: The process by which microorganisms are destroyed. Conventional sterilization involves heating the product to 125–130°C/257–266°F for 15–20 minutes. Ultra high temperature (UHT) processing requires heating to 140–150°C/284–302°F for 2–4 seconds.

Surface tension: A set of forces generated on the surface of a liquid that is in contact with another medium. For example, emulsifiers decrease surface tension and allow immiscible components to form emulsions.

Syneresis: Separation or detachment of a liquid, usually water, from a gel or thickened solution. Related to hydrocolloids.

Synergy: Increase in the properties of a product or creation of new properties caused by the interaction of the product with another product.

Thermoirreversible (thermostable): Stable in the presence of temperature changes. A thermoirreversible gel cannot be destroyed by the application of heat.

Thermoreversible: Property of a gel in which its consistency depends on temperature. A thermoreversible gel will melt with the application of heat.

Thixotropic: Characteristic of a gelling or thickening agent by which it can reconstitute a gel or thickened solution after it has been destroyed. Requires a fixed time to return to the original gelled or thickened state.



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